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The Chicago Drainage Board, at its last meeting, accepted as final the decision of Chief Engineer Randolph stating that there is no provision in the contracts warranting him to change the classification of material complained of by the contractors. Mr. Randolph, in his report, said that he was fully satisfied that the execution of the contract under all its terms and at the prices stipulated would involve serious hardship to the contractors. But in these contracts there are only two classifications: (1) Solid rock, comprising all material found in its original bed, even though it may be so loose as not to require blasting, and (2) earth, muck, sand, gravel, clay, hardpan, boulders, fragmentary rock displaced from its original bed, and any other material overlying the bedrock. Messrs. Streeter & Kenefick, the contractors on Section E, who quit work several months ago, were directed by a resolution of the Board to resume work within ten days, under penalty of having the Board complete the work as provided in the contract. The outlook is very unfavorable for the release of any of the contractors from the difficulties due to the nature of the glacial drift encountered.

The bridging of the Chicago Drainage Canal promises some interesting engineering problems. These bridges must be swing bridges, and the Board is under legal obligations to erect and maintain six wagon bridges at highway crossings and a number of difficult railway bridges. Among the latter crossings is one of a cluster of six tracks, two each belonging to the Pan-Handle, Union Stock Yards and Northern Pacific systems respectively. This bunch of tracks is 75 ft. wide and crosses the channel on a skew. The channel, from Lockport to Willow Springs, is in the solid rock and is 162 ft. wide, with nearly perpendicular banks. North of Willow Springs the channel is 202 ft. at the bottom and 306 ft. wide at the water level. If "bobtail" rotating bridges are used, with the pier 50 ft. out in the shallow margin, there is still an opening of 256 ft. for the swinging bridge to cover; and when this bridge must be wide enough for six tracks the problem becomes a pretty large one.

The present condition of the Chicago Post Office building is a strong argument for the proposed Congressional reform in the manner of planning and erecting our public buildings. Health Commissioner Reynolds has just reported on the sanitary condition of this building, and it will be seen that many of the faults pointed out are inherent faults of design. The basement, in which 200 men constantly work, is dark, grimy and unventilated, and the sewerage is defective and badly designed. On the main floors there is the same lack of provisions for ventilation and the rooms are badly lighted. This fault is found throughout the building. Mr. Reynolds closes by saying the conditions are inexcusably bad and would not be allowed in any mercantile establishment in Chicago. He recommends prompt and vigorous action as necessary for the health of the employees.

A garbage-dumping vessel has been designed by Engineer-in-Chief Melville, of the Navy Department, and the plans are offered gratuitously to the city of New York. He proposes a vessel 194 ft. long, 35 ft. beam and 18 ft. deep, designed to carry a load of 750 tons on a draft of 9½ ft. The garbage-stowing capacity would be 21,000 cu. ft., the compartment occupying 100 ft. of the length of the vessel. The bottom of this compartment slopes from the middle line to the two sides of the ship, with the foot of the slopes above the water-line when the vessel is light. Along the sides of the ship are hinged doors which are opened automatically from a longitudinal central bridge protected by bulkheads, and the garbage can be discharged without shipping water. The vessel is to have a speed of at least 10 knots, and will thus be able to go to sea in all weather for 20 miles and return in less than four hours. A powerful steam pump will be used for washing out the garbage bins, and this pump can also be used for fire purposes along the docks. The plant proposed includes two vessels of this type; five smaller boats of a similar kind, 108 ft. long and holding 4,500 cu. ft. of garbage, and 28 towing scows built on the same principle with 5,000 cu. ft. capacity each. The space below the garbage bins furnishes air chambers sufficient to prevent sinking. The claim is made that these vessels could be built of steel for about the sum now annually expended in handling the garbage of New York.

The most serious railway accident of the week was a derailment on the Chicago, Rock Island & Pacific Ry., near Lincoln, Neb., Aug. 9, resulting in the death of 11 persons. Train wreckers had removed the spikes and bolts from the rails at the end of a high trestle crossing the tracks of the Union Pacific Ry. and Burlington & Missouri River Ry. When the Fort Worth accommodation train reached the trestle, the rails spread and the engine and two cars, after running some distance along the ties, went off the trestle, falling 40 ft. to the ground. Coals spilled from the firebox set fire to the trestle and the cars. The rear car had telescoped the forward car (smoking and baggage car) in falling, and the passengers in the latter were imprisoned in the wreck. Three passengers and a brakeman managed to get 14 people out of the rear car, and the baggage man and expressman were taken out badly burned, but nothing could be done for the others. The engineman, fireman, conductor and eight passengers were killed, and four persons were injured.

A collision of electric cars on the Freeland branch of the North Side Electric Ry., Hazleton, Pa., on Aug. 9, resulted in the injury of 25 persons. The conductor of a car waiting on a sidetrack ordered the motorman to go ahead, thinking the other car was late, and that he could reach the next siding. Both cars were running at high speed when they collided on a high bank. Many of the passengers jumped, but the cars telescoped and remained on the track.

A trestle near Peru, Ia., on the Chicago Great Western Ry., gave way under a freight train Aug. 7; the stringers having been weakened by fire. One man was killed and ten were seriously injured.——A trestle over Jonas Hollow, near Alto, Wash., on the Oregon Railway & Navigation Line, gave way under a freight train, Aug. 5. The engine got across in safety, but the tender and 15 cars went down. Three men were injured. The trestle was 300 ft. long and 90 ft. high.——A highway bridge near Springfield, Ill., gave way under a threshing machine Aug. 6, and two men were killed.——A bridge on the road from Leavenworth to Fort Leavenworth, Kan., gave way under a team Aug. 3, but nobody was seriously injured.——An old bridge over the Olentangy River, near Delaware, O., gave way under a traction engine Aug. 3, and two men were killed.

The works of the Sicilian Asphalt Paving Co., at Allegheny, Pa., were destroyed by fire on Aug. 2, but the loss involved is said to have been only about $7,000.

The upper part of an interior wall of the new city hall now being built at Jersey City, N. J., was blown down by a high wind on Aug. 9, and two men were killed and five injured. The wall was 12 ins. thick, 75 ft. long and about 60 ft. high.

The Holland submarine boat, described in our issue of Sept. 21, 1893, is to be again examined by the Construction Bureau of the Navy Department. Notwithstanding the adverse report of a board of experts a year ago, the chiefs of the bureaus are looking with favor on further investigation in this line.

A decision involving the right of trustees to accept other than the lowest bid in letting contracts was given in Cincinnati, on Aug. 9. The Water-Works trustees of the village of St. Bernard received bids for a pumping engine, in which the bid of the Laidlaw-Dunn-Gordon Co. was $1,547 more than that of the John H. McGowan Co. The trustees awarded the contract to the Laidlaw-Dunn-Gordon Co., and three taxpayers brought suit for an injunction to prevent the award. The court refused the injunction, first, on the ground that the McGowan Co. was the real plaintiff in the case, and, second, that the testimony failed to show that the trustees had not acted in good faith and within the limits of the discretion vested in them by statute.

A steam tramway or light railway is to be built by the government of British Guiana between New Amsterdam and Skeldon, on the Corentyne coast, Berbice. The government is now advertising for proposals for the construction and working of the line, and will grant a subsidy of $80,000 per annum for 20 years. Proposals will be received by the Government Secretary until Jan. 31, 1895.

The smallest electric railway in the world is said to be at Dellwood, Minn. It is about 350 ft. long and runs between the railway station and the summer home of a St. Paul banker. It is equipped with one motor car and two trailers, each 5 ft. long by 2 ft. wide, running on a 14-in. track. The "third-rail" system is used instead of a trolley. At the end of the line is a power house and a small machine shop, operated by a 2-HP. petroleum engine belted to a 2-HP. compound wound generator. The road is practically straight, with two gradients in it of 10 and 16%. Up these the motor car easily carries four adults and two children.

The trolley postal cars for Brooklyn suburbs, noted in our last issue, are now doing satisfactory service, giving four mails a day to distant points at less cost than the old tri-daily service. The Postmaster of Providence, R. I., is considering the introduction of trolley postal cars there for delivering mail matter.

The Cleveland, O., Electric Railway Co. proposes to make all its rails continuous, the joints being welded together by electricity. The tracks of this company are laid with 60, 82 and 97-lb. rails, and the first experiment is being made on the lighter rail. The weld is made in 15 minutes by the special welding car of the Johnson Co., of Johnstown, Pa.

Electric headlights for locomotives, though now in use on the Cincinnati, New Orleans & Texas Pacific and other railways, are not regarded with favor by many of the engine-drivers. They complain that the light is blinding and confusing, especially on passing engines, and interferes with the reading of signals, etc., and the lights on switch-targets are less distinct than with the old form of headlight. The Lake Shore & Michigan Southern tried the electric light some years ago and abandoned it.

The "caisson-gate," closing the Mare Island dry dock, at San Francisco, Cal., is reported as totally wrecked on Aug. 7. The accounts are meager, but the accident is ascribed to gross carelessness in leaving the dock filled after docking the U. S. S. "Thetis." The "tide falling" on the outside brought a pressure against the inside of the gate which it was not designed to withstand, and in consequence it was forced out carrying with it portions of the entrance masonry, entailing a loss of about $50,000 and possible injury to the "Thetis." We hope to give fuller details in a later issue.

A road convention is to be held at the Minnesota state fair, at St. Paul, on Sept. 11. The programme includes a lecture by Professor Hayes, of the state school of agriculture, on the practical building of dirt and gravel roads; there will also be a paper from Superintendent Berry, of the Minneapolis park system. In addition, there will be practical illustrations of the working of road machines, the building of macadamized roads, and an exhibition of cross-sections of roads. Proprietors of different road machines have been asked to exhibit their machines, and each of them will be allowed to grade a part of a half-mile track inside of the mile track on the grounds. The fair association has authorized one of its committees, in connection with the other preparations for this day, to secure material and lay out a section of a macadamized road for exhibition, and in addition to have for display statistics as to the cost of building such roads, and also to make arrangements so that any desiring instruction can be afforded it. An exhibit of stone crushers will also be made.

A large sewer tunnel is to be built at Niagara Falls, N. Y., as stated more fully in our proposal columns. The tunnel will be 7 × 9 ft. in cross-section, and about 3,500 ft. in length. In connection with this tunnel over a mile of 5-ft. brick trunk sewer is to be built. Of course this sewer is far larger than would ever be required for the present population, and the aim evidently is to provide for the needs of the manufacturing city which is expected to be built up by the cheap power furnished by the Niagara Power Co.

THE RESISTANCE OF MATERIALS UNDER IMPACT.*

By Mansfield Merriman, Ph. D.

The science of the resistance of materials, as taught in text-books and used in the daily practice of every engineer, is mainly that of static conditions where external force is resisted by internal stress. The question of resistance to the impact of falling bodies, liable to occur in machinery, on bridges, and to a certain degree also in buildings, is recognized as important, but it is seldom reduced to computation or made the occasion of careful experiment. Even the fundamental principles and laws regarding it seem often not clearly understood. Hence the subject of this address, which is an attempt to set forth the present state of our knowledge concerning impact, and to reconcile some of the apparent paradoxes that often arise in the discussion and application of its principles.

In 1807 Thomas Young announced the fundamental ideas of the resistance of materials under impact. "The action which resists pressure," he said, "is called strength, and that which resists impulse may properly be called resilience." He stated that the resilience of a body is proportional to its strength and extension jointly, and that it is measured by the height through which a given weight must fall to cause rupture. The resilience of beams of the same kind he made proportional to their volumes, as also the resilience of shafts, whether solid or hollow. He further suggested that a very high velocity of the moving weight may rupture a body by impact before its full resilience can be developed.

Resilience is thus the capacity of a body to resist applied work, or it is the internal work which can be developed by the energy of a moving body. External force is resisted by internal stress and the resulting deformation is a secondary consequence, but impact is resisted by resilience where the deformation is of equal importance with the stress, for internal work is the product of these two factors.

In Young's time the elastic limit of materials was but vaguely recognized, and Hooke's law of proportionality of stress to elongation was often applied to all the phenomena preceding rupture. Young's statements are valid in a general way, but we now know that it is necessary to distinguish between the two cases of elastic resistance and non-elastic resistance. Hence there are two divisions of the subject of impact: first, that of elastic resilience where the molecular forces do not surpass the elastic limit of the material, and second, that of ultimate resilience where the elastic limit is exceeded and rupture finally occurs.

The problems of elastic resilience are largely theoretical and mathematical. Their discussion begins with Young, and has been continued by a long line of investigators to the present time; it forms, indeed, the most prominent part of the theory of elasticity, which has been so thoroughly set forth in the history of Todhunter and Pierson. Starting with Hooke's law of proportionality of stress deformation, and applying to this the mechanical laws of force, velocity and work, the stresses, displacements and resilience of elastic bodies subject to impact have been deduced. The results thus theoretically found have been confirmed by many experiments, as must necessarily be the case, since all the laws of the discussion are those of experiment and experience.

The first problems of elastic resilience were those of bars or rods subject to the longitudinal impact of a moving weight. The vibrations of stretched wires had been discussed by Euler, Lagrange and others, but Navier, in 1823, appears to have been the first to investigate the oscillations and maximum stresses in a horizontal bar due to a weight impinging on its end. Poncelet, in 1829, treated the same problem for a vertical bar subject to longitudinal impact by a falling weight. These discussions showed that for the case of horizontal impact the maximum elongation is a mean proportional between twice the height of fall and the extension due to the same weight when applied gradually, while for vertical impact it is the sum of the static extension and the hypothenuse of a right-angled triangle, whose sides are this static extension and the dynamic extension started for the horizontal bar. It is a corollary from this that under the sudden application of a load, which is the particular case of impact when the height of fall is zero, the maximum elongation, and hence the maximum internal stress, is twice as great as that caused by the same load when applied gradually.

While speaking of Poncelet, it is well to pause to remark that his work on industrial mechanics which contains these investigations deserves especial mention as the book that marks the beginning of technical education; his conceptions and explanations of these problems of external work and internal resilience may indeed still be regarded as models of clear and accurate reasoning.

*Vice-presidential address, delivered Aug. 16, 1894, at the opening meeting of the Section of Mechanical Science and Engineering of the American Association for the Advancement of Science, in Brooklyn, N. Y.

The solutions of Navier and Poncelet for longitudinal impact on a bar were approximate in the sense that its weight was regarded as small compared to that of the striking body. Later investigations by Saint Venant, Boussinesq and others, have completely resolved the problem when the relative masses are taken into account, and have also disclosed all the attendant circumstances of duration and intensity of the forces at the surface of impact.

Another important problem is that of transverse impact on a beam giving rise to flexural resilience. The first investigation of this was by Hodgkinson, 1833, in connection with the discussion of experiments, while the full elastic theory for different ratios of weights of the beam and falling body was developed by Cox in 1848, and later most fully extended by the French elasticians in a similar manner to that of longitudinal impact. The law of proportionality of resilience to volume was shown to be true only when the latter is increased an amount proportional to one-half the ration of the weight of the beam to that of the striking body, and similar modifications are necessary regarding deflections and internal stresses. In all these problems the velocity of transmission of stress, which is the same as the velocity of sound in the given material forms an important element, as indeed Young had suggested in 1807 at the very beginning of the consideration of impact resistances.

While the conclusions of all these investigations of elastic resilience are true and valuable, it should never be forgotten that they are only true when the conditions are observed under which they are deduced, namely that the elastic limit is not exceeded by the maximum internal stress. Now, while the elastic limit for some materials is as high as one-half the ultimate strength, the elongation up to the elastic limit is small compared with the ultimate elongation, and hence the elastic resilience may be very small, less perhaps than one part in a thousand, compared with the total ultimate resilience. The phenomena of elastic resilience form, indeed, such a small portion of those occurring in practice, that it is difficult to observe them with precision, while those of non-elastic resilience are ever present. Many a misconception has arisen and many a paradox has been founded on the assumption that the theory of the smaller part is applicable also to the larger part of the phenomena.

The investigation of ultimate resilience is necessarily experimental, since beyond the elastic limit no theoretical relation between stress and deformation is known. In 1818, Tredgold, the founder of the oldest engineering society, made experiments on wooden beams subject to the impact of a falling ball, and concluded that Young's law of proportionality of resilience to volume was not justified. Hodgkinson, in 1835, experimented on cast iron beams under lateral impact from a pendulum and found that the deflections were proportional to the velocities of impact, that the same work was required to break the beam whether struck at the middle or at the quarter point, and that the weight of the beam increased its ultimate resilience, all of which is more nearly in accordance with the elastic theory than perhaps might be expected. In 1849 was published the "Report of the Commissioners Appointed to Inquire into the Application of Iron to Railway Structures," which contains some of the most comprehensive and valuable experiments ever undertaken. In view of later practice it was perhaps unfortunate that these were mostly made upon cast iron, but the methods of investigation and the conclusions deduced render this report an epoch-making one in the history of the resistance of materials. Here can only be noted those points relating to impact, on which experiments were made by Hodgkinson, Willis and Galton. Transverse impact on beams by oft-repeated blows of a ball swung as a pendulum, and also by pressure applied by a revolving cam, indicated for the first time the laws of fatigue under repeated stresses; transverse impact with a single blow confirmed Young's theorem of resilience and volume, as the same amount of work was required to rupture a rectangular beam whether struck on its narrow or broad side; and the inertia of the beam was shown to be an important factor in increasing its resilience. Weights suddenly applied without impact gave deflections nearly double the static deflections and the same ratio was observed in the breaking loads. Experiments on the effects of a load moving with different velocities over a beam showed that the deflection could amount to more than double the static deflection, and the elaborate theoretical discussions of this case by Stokes, together with the evidence given by experienced engineers, form the basis of many practical rules since used in bridge design. The immediate result indeed was the revision of the factors of safety by the British Board of Trade and the establishment of a rule that for cast iron the factor for live load should be double that for dead load.

The 30 years following the middle of the century may be designated as the period of development of the modern methods of static tests upon tensile specimens. In the United States this development, begun by Wade, Rodman and Plympton, later produced the numerous testing machines of Fairbanks, Olsen and Riehle, and at last has culminated in the precise apparatus of Emery and in the powerful machines at Athens and Phoenixville. These static tensile tests seem to have diverted attention from the question of impact, and to have caused the neglect of the theory of resilience, for the objects of the method have been mainly to determine the elastic limit, maximum strength and ultimate elongation, considerations of work having been largely overlooked. Yet the diagram formed by laying off the unit-stresses as ordinates and the corresponding elongations as abscissas shows by its area the internal work which resists rupture, and thus is approximately a measure of the ultimate resilience per cubic unit of the material. The phenomena in a slow test, however, are not in all respects the same as in a rapid one, the elastic limit and maximum strength being generally greater in the latter while the elongation is less. How the diagram would look under the very rapid development of stress is yet to be determined, and not until this is done by an autographic device can a full knowledge of the total field of resilience be obtained. High values of the ultimate elongation and contraction of area have been regarded as of great importance in judging of the quality of iron and steel, and this has given rise to what may be called an unconscious manipulation of the machine, the power being applied at such a rate as to secure these results consistent with other conditions. It is safe to say that stresses are not applied, and that rupture does not occur in this manner in practice, and here it is that static tests fail to give full satisfaction.

It would be easy to take a great deal of space in criticism of the imperfections of the static method of testing, to show the uncertainties of percentages of elongation, to dwell on the discrepant results found from specimens of different shape, and to state the various views regarding contradiction of area and the appearance of the fracture. But this is not the place. It may be said again, however, that the work per cubic unit developed before rupture is an important element by the study of which much can be learned, for the total resilience depends not merely on maximum strength and ultimate elongation, but upon the rate of variation of these throughout the test. Each material, or specimen, by virtue of its physical and chemical properties and its method of manufacture, has the capacity for resisting a certain amount of applied work of which the quantities measured in the static test are not complete factors. The full resilience can indeed only be found from an autographic diagram like that used in Thurston's torsion machine, which has done good service in this direction.

During all this development of static testing one impact test has survived and everywhere held its own. This is the cold bend test for wrought iron and steel. In the rolling mill it is used to judge of the purity and quality of the muck bar; in the steel mill it serves to classify and grade the material almost as well as chemical analysis can do, and in the purchase of shape iron it affords a quick and reliable method of estimating toughness, ductility, strength and resilience. It is true that numerical values of these qualities are not obtained, but the indications are so valuable, that if all tests except one were to be abandoned, the simple cold bend test would probably be the one which the majority of engineers would desire to retain.

Returning now to impact experiments proper, the experiments of Kirkaldy, in 1862, deserve notice. He subjected wrought iron specimens to sudden tensile stress by loads which were applied without velocity, and found that they broke with 82% less load than under static conditions. This has since been quoted as a contradiction of the law that the stress produced by a gradual load is one-half that caused by the same load when suddenly applied, but really no contradiction exists, since the law is only true when the elastic limit is not exceeded. For ultimate resilience the ratio of gradual to sudden load producing the same stress is always greater than one-half, and approaches nearer to unity the more ductile the material. Kirkaldy also introduced the ultimate contraction of area as an element of equal importance with the ultimate elongation, and undoubtedly this is the case, since it is subject to less variation with the length of the specimen. However, little satisfactory evidence exists that contraction of area is a measure of resistance to impact, as some have supposed.

The impact hammer or ram delivering repeated blows as used by Sandberg and Styffe in 1868 on railroad rails and by the United States Board for Testing Metal in 1878 in experiments on chain iron, is perhaps the most common method of conducing tests for resilience. The weight of the ram multiplied by the height of fall measures the work done in one blow, and the number of foot-pounds required to produce rupture furnishes an index of the ultimate resilience of the bar or specimen. Although valuable for comparative purposes, like the cold bend test, this method fails to give proper numerical results, since the effect of a

second blow is not really added to that of the first on account of the dissipation of internal work into heat which follows the release of the stress when this is greater than the elastic limit. That the work of several blows affords little indication of ultimate resilience was well shown by Uchatius, in 1874, who experimented on rods of small size under the impact of a small ram, and found that rupture could be caused by one blow of 28 ins. fall giving 6 ft.-lbs., by four blows of 21 ins. fall giving 18 ft.-lbs., by 37 blows of 10½ ins. fall giving 83 ft.-lbs., or finally by 2,050 blows of 3½ ins. fall giving 1,536 ft.-lbs. of work. Indeed, the fact that one strong blow is more efficient than many weak ones is well known to every artisan. The comparative weights of the ram and bar are also of importance in such tests, as will be later noticed.

The rise of the elastic limit after the release of a stress which surpasses it, first shown by Thurston in 1873, and the consequent stiffening of the material under several such applications of stress, is also observed in cases of repeated impact. Thus Martens, in 1879, tested a railroad rail by a ram falling alternately on the head and base; the second blow produced only 95% of the deflection caused by the first, and after four or five blows only 90% was obtained. Here, of course, a large part of the work of each blow was dissipated in heat due to the change of molecular structure, so that the total work expended gives no valid numerical measure of the true ultimate resilience of the material. Our knowledge as to what occurs under such repeated impacts is of the most uncertain kind. Most of the stresses are no doubt injurious, as the final result proves, but a few may perhaps be beneficial in improving the quality of the material, like the process of cold-hammering and cold-rolling in manufacture. Bauschinger's discovery in 1885, that the raising of the tensile elastic limit is accompanied by a lowering of the compressive elastic limit, is a most important one, which is likely in connection with future investigations to lead to a clearer knowledge of the laws of stress in materials under repeated impact.

The investigations of Woehler between 1860 and 1870, and the later ones of Spangenberg, on the resistance of materials under repeated stresses applied with little impact, have been of the greatest value in influencing the rational design of bridges and other structures subject to variations of load. They establish the facts that repeated stresses below the elastic limit do not injure the material, that repeated stresses beyond this limit cause injury in proportion to the range between the maximum and minimum limits, and that the greater the range the less the number of repetitions required to produce rupture. The prompt adoption of rules for designing based on these conclusions, in place of the arbitrary methods of adding 20 or 30% to the static stresses, indicated that the engineering profession appreciated the importance of providing for the resistance to impact in a rational way. Yet probably greater impacts occur on bridges than these repeated stresses, for failures are not infrequent and the life of a bridge under heavy traffic scarcely exceeds a dozen years. The further study of the effect of repeated impact is thus imperative, for what we now know is but little compared to what is to be learned.

Maitland, in 1887, showed by many experiments on tensile specimens subject to many blows of a falling ram that the ultimate elongation was greater than in static tests, it being in some cases nearly doubled. This might, perhaps, be expected from what has been said regarding the beneficial influence of some of the stresses. He also exploded powder and gun-cotton between two cylinder heads joined together by rods, and found their ultimate elongation to be more than double the corresponding ones under static stress. This, on the other hand, might not have been expected from the general conclusions regarding the effect of time on stress and elongation, and it seems not to be the case for the impact of a single blow in later experiments. Thus, it appears, in problems of ultimate resilience, where no theory has yet been developed, that general principles derived from static tests should be applied with caution.

The tests made by E. D. Estrada, in 1893, have recently led to much interesting discussion on the subject of impact. Specimens of wrought iron and steel were tested by the usual tension machine, and also under the blow of a ram weighing 100 lbs. falling through vertical heights ranging from 5 to 25 ft. Over 40 specimens were broken under repeated blows, they being so arranged that they were brought into tension by the pressure caused by the impact. The number of blows ranged from 2 to 14, the height of fall varying in different cases. These valuable experiments show clearly that the ultimate elongation under repeated impact is greater than for static stresses, the average of all being about one-third greater, while the contraction of area shows only a small increase; but no conclusions regarding the elastic limit or the maximum strength under impact can be derived from them. The impact was not directly applied to the specimen, but through a number of plates and bolts through which it was transmitted, and thus much of the work was spent in acting against their inertia and resilience. This, however, in no way invalidates the important deductions regarding the influence of repeated impact on ultimate elongation and contraction of area, and the conclusion of Kirkaldy regarding the value of the latter as an index of toughness and ductility is thoroughly confirmed. The elongation before rupture appears to vary approximately as the amount of work expended by the ram, but the work required to produce rupture does not give a satisfactory comparison of the ultimate resilience of different specimens, except in those cases where the height of fall was the same.

The experimental work thus briefly reviewed has been done by special improvised apparatus, and with little or no uniformity of method, but the time may come when machines for impact tests will be put on the market and be in common use. At present almost the only one that can be mentioned is that devised by W. J. Keep, about 1889, for testing the resilience of cast iron. The blows are delivered by a hammer weighing 25 lbs., falling like a pendulum through heights less than 6 ins., and produce horizontal flexure at the middle of a small bar 1 ft. in length. Beginning with a fall of ⅛ in., successive blows are applied, each with a fall ⅛ in. greater than the preceding, until rupture occurs. The deflections and sets of the bars are graphically recorded by the machine itself, and thus excellent comparisons of the ultimate resilience of different grades of metal may be obtained.

Impact tests are most important in the case of railroad rails, car wheels, tires and axles, and other forms liable to shock. Such rail tests have been carried on for many years in Europe, and since 1890 in the United States by P. H. Dudley. Already at least three prominent railroads require drop tests of steel rails to be made at the mill. One rail but 4½ ft. long is to be taken from each heat, placed on solid supports with either head or base upwards and a weight of 2,000 lbs. is dropped upon it, the height of fall being 16 ft. for rails lighter than 70 lbs. per yd. and 20 ft. for heavier ones, while the distance between the supports is 3 ft. for the former and 4 ft. for the latter. Under this test 90% of the rails must not break, and the elongation of the base or head under the greatest tension must be more than 5%. This requirement of testing by a single blow is in every respect more satisfactory than by several repeated ones, as the deflection and deformation are produced by a known quantity of work and the complex phenomena of stiffening and the loss of work in heat are largely avoided.

It is to be hoped that the many important experimental results obtained by Dudley in conducting these tests may soon be published. By his kind permission I can here state, however, that they indicate that the deflection is proportional to the height of fall of the ram instead of to its square root, as in elastic resilience, that both the deflection and the extension on the tensile side are slightly less than in the usual static tests of rupture by flexure, and that the elastic law of proportionality of resilience to volume seems not to apply. His experiments now in progress at Scranton promise to give most valuable information regarding the intensity and variation of the pressure between the ram and the rail at the moment of impact, while by measurements of the extensions and compressions over the whole length of the base and head, data are obtained which will render possible a satisfactory computation of the actual internal resilience developed by the applied work.

Aside from the physical qualities of the metal, impact tests on rails and wheels promise to give important conclusions regarding the influence of temperature, of chemical composition, and of methods of manufacture, and thus to lead to a better, more uniform and cheaper product. The discovery by Goss, in 1892, that the driving wheels of a locomotive lift up from the rail during a part of each revolution when moving at high speed shows that impacts are of more common occurrence than generally supposed, and to satisfactorily resist these an increased resilience in wheels, rails and bridges is required.

At the closing session of the Engineering Congress held last year in Chicago, a resolution was offered by Debray that uniform methods of testing are desirable for purposes of comparison, and it was adopted unanimously. For common static tests of tension and compression the time has certainly arrived when rules to secure uniformity should be framed and followed. The conferences held at Munich in 1884 and at Dresden in 1886 made a good beginning, and the later work done in 1891 by the Committee of the American Society of Mechanical Engineers will undoubtedly bear good fruit. With respect to impact, however, our knowledge is not yet sufficient to frame uniform rules. The recommendation that the weight of the anvil, or supporting blocks which hold the specimen, should be at least ten times that of the ram is an excellent one, but others fully as important will doubtless be developed by further rational investigation and experiment.

The influence of the inertia of the resisting body in modifying the effect of the impact should not be forgotten. If the ram be light, local damage in the body struck will be the result rather than the development of its resilience. Cotterill has suggested for the case of transverse impact that if the total work of the ram be taken as proportional to its weight plus one-half the weight of the beam, then the work spent in developing resilience may be taken as proportional to the weight of the ram and that spent in local damage to one-half the weight of the beam. This is a good rule to keep in mind, for longitudinal impact producing pure tension, one-third being the fraction to be used instead of one-half. The fall of the ram should not be too great, for a high velocity of impact is also apt to cause the work to be spent locally, since time is required for the transmission of internal stress. The cutting of hard steel plates by the impact of particles of sand at high velocities is an example familiar to engineers, and that drops of water will wear away stone is known to all; hence a low fall combined with a heavy ram seems best adapted for conducting impact tests where the most satisfactory numerical results are desired.

It may further be suggested that the blow should be delivered directly to the beam or specimen without the intervention of intermediate blocks or parts which may absorb work. At the same time the surface of contact should be sufficiently large so that the compression of the ram may not, if possible, exceed the elastic limit, and thus loss of work in heat be avoided. In elastic resilience the applied work is not transformed into heat, in resilience accompanied by permanent deformation it is, and hence the tests should be so conducted that the specimen and not the ram may be heated. Lastly, it may be noted that the rebound of the ram should be subtracted from the total fall to give an exact measure of the work actually performed by it upon the body which is tested.

The violent impacts due to the explosion of dynamite, or to projectiles striking against armor plates, constitute a branch of the subject which can receive but a moment's attention here. In such cases the velocity of impact is so great that the time for the development of resilience by the distribution of internal stress is very short. The velocity of the transmission of stress in steel is about 17,000 ft. per second, and a velocity of 2,000 ft. per second is probably very near the limit where a projectile may be expected to cause local damage of some kind. The stresses in this case are those of direct compression, or rather pulverization, and perhaps even combustion may occur under the intense heat developed. Formulas for penetration, based on shearing stresses, have little validity under such extreme conditions, and the material on the surface of modern plates is one whose physical properties are quite unknown, except in respect to hardness. Indeed, the subject of these violent impacts is one for which no theory will long be possible, although Boussinesq made a beginning in 1882 for the case where the elastic laws are observed. However, the indications are that, in the conflict for supremacy between projectile and plate, the former has the better chance for ultimate success.

Having now passed over in rapid review the state of our knowledge of the resistance of materials under impact, a brief consideration should be given to the contradictions or paradoxes that constantly arise in discussions of the subject. Of these the most common is that the theory of elastic resilience is incorrect, because it is not verified by the phenomena of ultimate resilience. It has already been pointed out that the principles of the two cases are necessarily different. It is a principle of elastic resilience that a force suddenly applied to a rod or beam produces double the elongation and double the stress caused by the same force when gradually applied, but this is not true when the elastic limit is exceeded, and it should not be expected to be true, when materials are tested to destruction. Hodgkinson found it closely verified for cast iron, but this is because the ratio between stress and elongation of that material is not subject to wide variation, while an elastic limit scarcely exists. Kirkaldy found it not verified for wrought iron, and this is because of its great elongation beyond the elastic limit. So with the deflection of beams under ultimate resilience, cast iron agrees fairly with the elastic law, while wrought iron does not, and the reason is the same as before. So with the elastic law of the proportionality of resilience to the volume of the bar, cast iron is found to fairly agree under conditions of rupture, while wrought iron and steel probably do not, and in neither case are the elastic laws affected. The old paradox in the theory of beams is of a similar nature; the modulus of rupture derived from the static formula does not agree with the tensile or compressive strength of the material; but this in no wise reflects on the truth of the formula whose theory supposes the elastic limit to be not exceeded.

The numerous efforts to compute the pressure caused by the impact of a ram form a series of paradoxes which originate in defective mechanical conceptions. The frequent assumption that the pressure is equal to the momentum is one of these which has, of course, no reasonable basis, except in the particular case when the ram is brought to rest by a uniform resisting force in one second of time. The assumption that the pressure varies directly with the fall, or with the work done by the fall of the ram, has no reasonable basis

at all. The correct principle here is, as well elucidated by Skinner in 1877, that the mean value of the pressure multiplied by the distance through which it acts is equal to the total work done in the fall, but this gives no idea of the variation of the pressure or its maximum intensity, except for a few problems in elastic resilience.

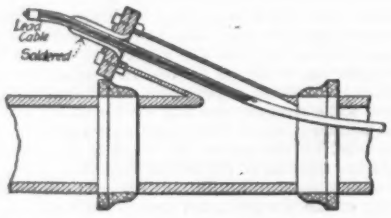
In recent discussions of Estrada's tests the paradox of equating foot-pounds of work to pounds of stress has arisen, with the result that it has been claimed that the elastic limit drops almost to zero in cases of impact. It is scarcely necessary to note here that the principles of mechanics lead to no such conclusion. As already stated elastic resilience forms so small a part of total resilience that it often passes unobserved, but resilience is not stress and there is no way in which they can be correlated except by combining the latter with the deformation that it produces. Keep's tables for impact are nothing more than the statement that the pressure produced by a blow is 5.42 lbs. for each ft.-lb. of work; but it should be said that he fully regards this as arbitrary, and valuable for comparative purposes only.

These unnecessary paradoxes and misunderstandings can be dispelled only by a clear conception and correct application of the fundamental laws of mechanics. The definitions of force and stress, work and energy, and all the words employed, must be clearly understood, and the law of conservation of energy be made the basis of every step of the reasoning. Too great attention cannot be given in our technical schools to the elucidation of these fundamental conceptions in view of the lack of precision which is so frequently apparent. Even the discussions of Herbert Spencer in the first volume of his philosophy appear poorly adapted to inculcate sound principles; for there are no laws of persistence of force and of continuity of motion as his words imply, but the phenomena of both force and motion are merely consequences of the great law of energy, and in any particular case either force or motion may vanish as the energy becomes either kinetic or potential. Language is oftimes an imperfect instrument for communicating thought, and algebra usually beclouds the reasoning whose tool it is; hence, it seems to me that these fundamental conceptions may be better fixed in the minds of students by practical experiments and numerical computations than by the mere study of books and the solution of algebraic exercises. The laws of mechanics are the laws of experience, and the best knowledge of nature is the solid ground of direct interrogation and investigation.

In conclusion, it may be noted that the pages of engineering literature contain much testimony as to the importance and value of impact tests. As a single example, Baker, the engineer of the Forth bridge, said in 1884 that for judging the ductility of metal the method of direct tension would apply in one case in a hundred, but in the other 99 the simple cold bending of a bar was generally used and was just as sound a test. The idea that the internal resisting work of a material is the best measure of all its physical qualities has been advocated in Germany by Hartig, and the law of proportional resistances announced by Kick, in 1879, indicates a wide field of valuable applications for the future. The theoretical work done in France, the drop tests for rails through all Europe, the experiments of Dudley and others in the United States, furnish additional evidence of the growing appreciation of the value of the study of impact. Indeed, it is not too much to hope that in a few years methods may be devised by which full numerical information regarding all the physical qualities of materials can be obtained from simple tests of their elastic and ultimate resilience.

A TELEPHONE WIRE IN A SUBMERGED WATER MAIN AT VANCOUVER, B. C.

A telephone wire has recently been placed in a submerged water main beneath The Narrows at



Method of Inserting Telephone Cable in Submerged Water Main, Vancouver, B. C.

Vancouver, B. C. The main was laid in 1888, the work being described at length in Engineering News of Feb. 2, 1889.

At low tide the pipe is submerged over a length of 1,086 ft. and extreme high water covers 2,800 ft., the corresponding depths of water at the deepest point being 58 and 72½ ft. The tides are so strong that attempts to maintain a telephone cable on the bottom of The Narrows proved futile. This cable was designed for communication between the head of the water supply conduit and the city. The idea of placing the telephone wire in the submerged main is credited to Col. T. H. Tracy, City Engineer of Vancouver.

A lead-covered cable, protected by saturated fibrous material and furnished by the Standard Underground Cable Co., of Pittsburg, Pa., was drawn through the pipe and joined to a lead special at each end, as shown in the accompanying cut. The cable has given satisfactory service thus far and promises to continue to do so for a long time to come.

We are indebted to the "Electrical Engineer" for the accompanying illustration and for the information regarding the construction of the cable.

NOTES FROM RECENT WATER-WORKS REPORTS.

No city on this side of the Atlantic, to say the least, makes more careful studies of the quality of its water supply than the city of Boston. During

View of New Inlet Tower at Chain of Rocks, St. Louis Water-Works.

the year 1893 there were made in the biological laboratory at the Chestnut Hill pumping station 2,505 microscopical and 1,725 bacteriological examinations, and 25 different species of bacteria were isolated and studied. Investigations of the tastes and odors imparted to water by micro-organisms were also made, and, in addition, weekly color examinations of the water throughout the system, from the brooks to the tap water at the extremities of the distributing mains. Mr. Desmond Fitz Gerald, Superintendent of the Western Division, has devised a new colorimeter and made very careful studies of the best method of determining the amount of color in water, all of which is set forth in the report of the Boston Water Board for 1893. Filtration experiments have also been made at Chestnut Hill and the water is subjected to chemical examination at frequent intervals. Mr. Fitz Gerald is in charge of all this work, while Mr. G. C. Whipple has been the assistant in charge of the biological work, with Mr. William E. Foss in charge of the filtration experiments. Mr. Foss has also assisted in the color work.

The report of the Lawrence Water Board for 1893 contains a description, with many views, of the new filter beds, put in operation last fall. These beds were illustrated and described in Engineering News of Aug. 3, 1893. Mr. A. H. Salisbury is superintendent of the Lawrence Water-Works.

Many views of the work of putting down driven wells at Lowell, Mass., accompanied by plans and a report by Mr. George Bowers, City Engineer, are presented in the last report of the Lowell Water Board. Mr. Bowers read a paper on this subject before the New England Water-Works Association last June, an abstract of which was given in our issue of June 21.

Regarding the use of meters, Mr. R. C. P. Coggeshall, superintendent of the water-works of New Bedford, Mass., says in his last report:

> Meter measurements are fair and equitable. Complaint is occasionally made that the system sometimes pinches the pocket-book of the taker pretty hard. This may be true, if a large amount of water has been allowed to run to waste, and it then pinches to some purpose, if the taker will only heed the warning which is taught by such an object lesson.

The first annual report of the Water Commissioners of North Brookfield, Mass., issued this year, contains a number of pleasing views and some details and plans of the new water-works, which were built with Shedd & Sarle, Worcester, Mass., as engineers, and Charles A. Allen, also of Worcester, as consulting engineer. An interesting feature of the works is an aerating fountain, so constructed that by a change of fixtures different effects may be produced.

Almost all the leaks in water mains at Waltham, Mass., in 1893, occurred in the cement-lined wrought iron pipe, which is being replaced with cast iron as rapidly as is practicable. Mr. George E. Winslow is superintendent at Waltham.

Woonsocket, R. I., with 1,340 of its 1,547 taps metered, or nearly 90%, had an average water consumption in 1893 of only 22.38 gallons per inhabitant, or 25.43 per consumer. Of the 1,340 meters, all but 39 are on domestic services. The population of the city is about 25,000. Mr. B. I. Cook is superintendent of the works.

The maximum and minimum meter rates per 1,000 gallons charged in 121 cities are given in tabular form in the report of the Water Commissioners of Erie, Pa., for 1893. In addition to the meter rates, the ownership of the works, whether public or private, is given, together with the 1890 census population of each city and the mode of supply, whether by gravity or pumping, or both. The cities are arranged very conveniently for reference in the order of the minimum rate charged. The lowest minimum rate is 2¼ cts. per 1,000 gallons, at Harrisburg, Pa., which has a maximum rate of 8 cts. The maximum and minimum rates at Buffalo are 2½ and 6 cts. respectively, and at Detroit 3⅓ and 6⅔ cts., which places these two cities at the foot of the list of low ranges of rates. Little Rock, Ark., is reported as having a maximum rate of $3 and a minimum of 12½ cts., evidently designed to discourage the use of meters by small consumers. The minimum rate in 79 of the cities is 10 cts., or less, and in 117 of the 121 cities is 25 cts., or less, but Dallas, Tex., reports a uniform rate of 50 cts. per 1,000 gallons. A flat meter rate of 6 cts. was adopted for Erie in 1893. Mr. Wm. Himrod is Secretary of the Water Commissioners.

Another city which reduced its meter rates in 1893 to the uniform charge of 6 cts. per 1,000 gallons was Saginaw, Mich., but here this rate is for manufacturers only. Both Erie and Saginaw, however, have comparatively few taps metered. Mr. John Weller is superintendent of the Saginaw works.

The amount of sediment deposited in the St. Louis settling basins during the year 1892-3 was 234,000 cu. yds., or 14.2 cu. yds. per million gallons pumped into the basins. Of the sediment deposited 160,000 cu. yds. were removed by manual labor, at a cost of $2,811, or 1¾ cts. per cu. yd. Owing to the increased consumption, the basins were used more as reservoirs than for settlement, and thus less sedimentation took place than would otherwise occur.

The inlet tower at Chain of Rocks on the new low-service supply of the St. Louis works is shown by the accompanying view, taken from the last report of Mr. M. L. Holman, M. Am. Soc. C. E., Water Commissioner.

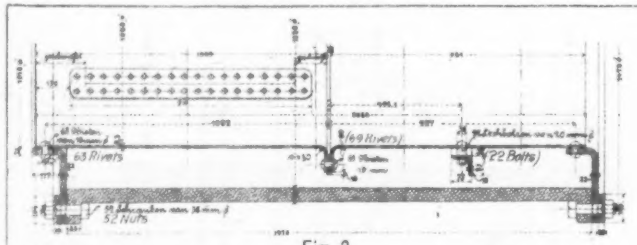
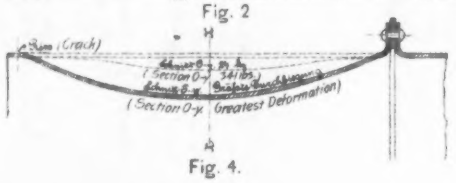


Fig. 2



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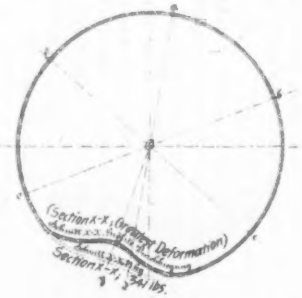

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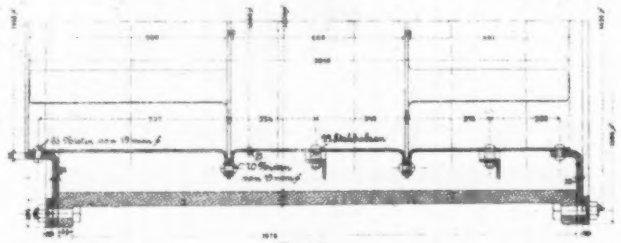

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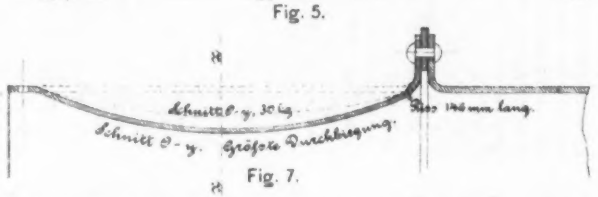

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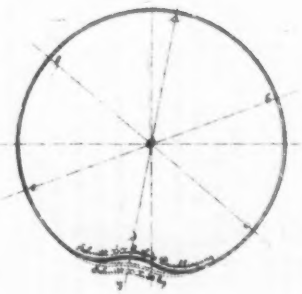

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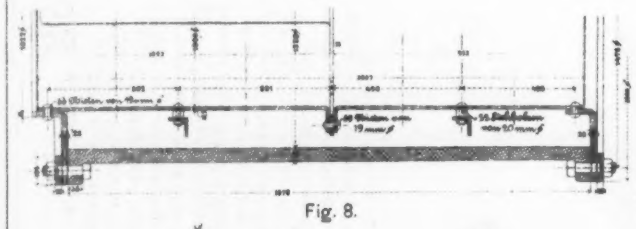

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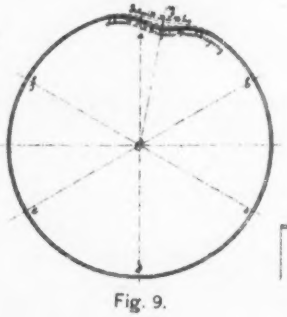

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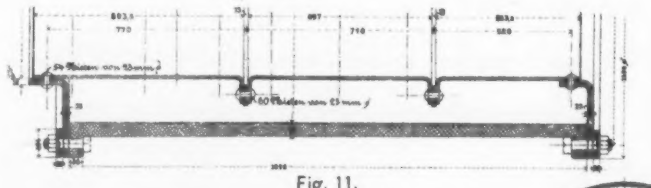

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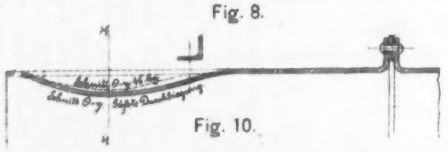

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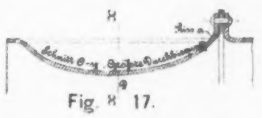

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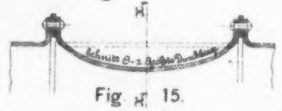

Fig. 15.

Fig. 16.

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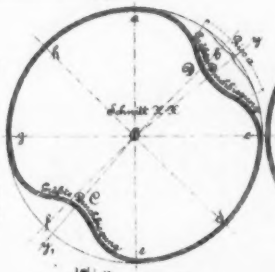

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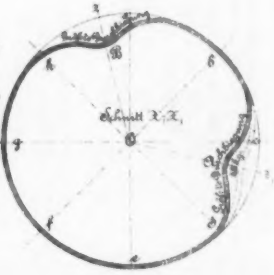

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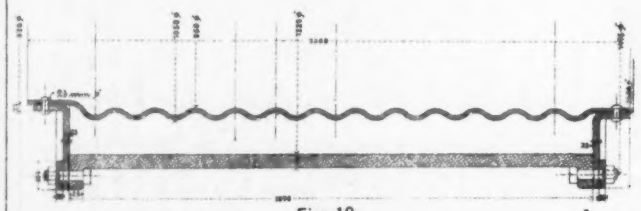

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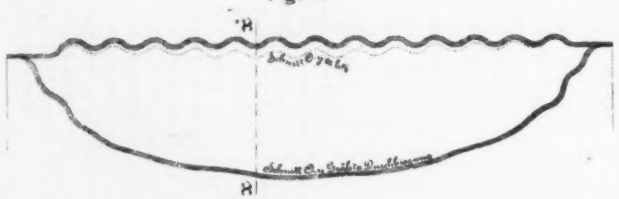

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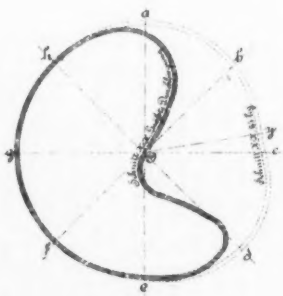

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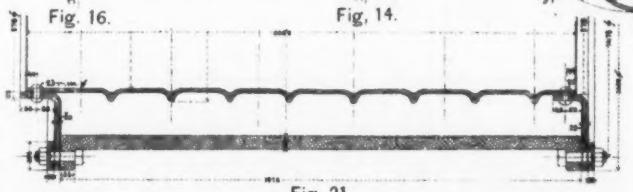

Fig. 21.

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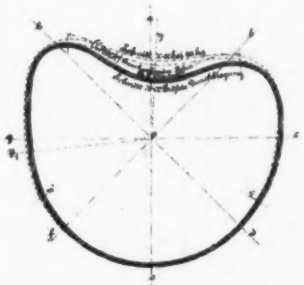


Fig. 22.

Tests of the Resistance of Boiler Furnaces to Collapsing.

Conducted at the Imperial German Navy Yard at Danzig.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

TESTS OF THE RESISTANCE OF BOILER FURNACES TO EXTERNAL PRESSURE.*

(With Inset.)

A series of tests was carried out by the German naval authorities during the years 1887 to 1892, to determine the ultimate resistance to collapsing pressure of the furnaces of internally-fired boilers. The tests were carried out at the Imperial Navy Yard at Danzig and were described by Prof. C. Bach, a prominent German mechanical engineer, in a recent issue of the "Zeitschrift des Vereines Deutscher Ingenieure."

The Fairbairn experiments on the resistance of tubes to collapsing pressure (Transactions of the Royal Society, 1858) were principally made with very thin tubes and of small diameters. Of 32 tubes tested, 26 had a thickness of 0.043 in., five of 0.13

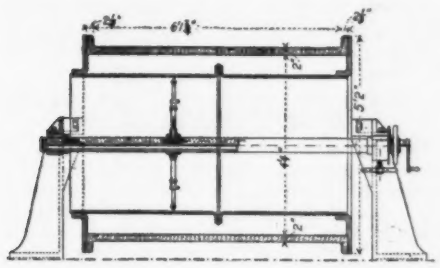


Fig. 1. Apparatus Used in Testing Resistance of Furnaces to Collapsing Pressure.

in. and one was 0.25 in. thick. The average diameter was 10 ins. At present boiler furnaces are made from ¼ to 1 in. thick and 2 ft. to 6 ft. in diameter. It is somewhat doubtful, therefore, how far the results of the Fairbairn experiments are a safe guide in computing the strength of boiler furnaces at present in use.

The tests at the Danzig Navy Yard were made with furnaces of 0.30 in. to 0.60 in. in thickness and 37 ins. to 40 ins. in diameter. The furnaces tested included 14 plain furnaces, 4 corrugated furnaces and 1 Purves ribbed furnace. All the furnaces tested were new.

The testing apparatus, Fig. 1, consisted of a cylinder of forged steel, 52 ins. in diameter, 6 ft. 6 ins. long and 2 ins. thick, with end flanges to which ring flanges were bolted, a tight joint being made with red lead. The furnaces to be tested were riveted to these ring flanges, as shown on our inset sheet. The annular space between the tube and the cylinder was connected with hydraulic pressure pumps and two pressure gages were attached. To measure the deformation of the furnace under pressure, a shaft was run centrally through the cylinder, as shown, and a radial extensible arm, carrying a graduated scale, could be revolved by the crank on the shaft and could be traversed upon it by a screw, as shown. The index on the radial arm read to .004 in. In making the experiments, the hydraulic pressure was increased in increments of about 71 lbs. per sq. in., until the first deforming of the furnace occurred, accompanied by a sudden fall in pressure. After measuring the deformation, the pressure was again raised until further increase became impossible by excessive leakage through the joints, due to deformation or through cracks in the metal. Between $12,000 and $14,000 was expended on the series of experiments.

Results of the Tests.

Referring to the inset sheet, Fig. 2 shows two rings of a plain furnace riveted into the testing apparatus. Each ring had a longitudinal joint welded at the ends and spliced in the center by two plates. At a pressure of 341 lbs. per sq. in., deformation, shown by dotted lines in Figs. 3 and 4, took place suddenly, the pressure dropping to 114 lbs. Further pumping raised the pressure to 242 lbs. The deformation increased, and the plate finally tore apart between three adjoining rivets of one end sheet joint. The crack is on the line of the greatest deformation and is due to the combined tensile and bending stress.

Figs. 5 to 7 show a test of another plain furnace. The tube deformed, at a pressure of 427 lbs., between two staybolts of the reinforcing angle iron, the pressure dropping to 398 lbs. Further pumping raised it to 455 lbs., when the increasing deformation pulled off the heads of the two staybolts.

This experiment shows clearly the weakness of reinforcing rings. The staybolts, which were placed here 5½ ins. between centers along the circumference, change the circle into a polygon; if spaced closer, the narrow spaces between tube, ring and staybolts are the more easily filled up with scale. In the section x_1 x_1 of greatest deformation the deviation from the circular shape, before the test, was a maximum of 0.24 ins. in the diameter of 39.4 ins.

The furnace shown in Figs. 8, 9 and 10 deformed at 640 lbs. pressure, the indentation extending between two staybolts of the reinforcing ring. The pressure dropped to 426 lbs., but was raised later to 512 lbs. The deformation increased until finally the head of one staybolt came off, whereupon the plate was stripped over the threads of this bolt.

Of the other tests with smooth tubes, that shown in Figs. 11 to 17 is of especial interest. At 682 lbs. pressure the center ring deformed as shown by the dotted line in Fig. 14. The test piece taken from the deformed place afterwards showed a thickness of 0.468 in. The pressure fell to 398 lbs. At 711 lbs. pressure the deformation C, Fig. 16, occurred in the left ring, in consequence of which the pressure dropped to 427 lbs. The test piece was 0.472 in. thick. At 725 lbs. pressure the indentation D in the left ring took place, Fig. 17, the pressure dropping again to 427 lbs. The test piece had a thickness of 0.476 in. A new increase of pressure to 725 lbs. caused the deformation B, as shown by Fig. 14, in the central ring. The test piece was 0.476 in. thick.

The renewal of some rivets and recalking of seams made it possible to raise the pressure 768 lbs., at which pressure the left-hand ring tore, Fig. 17.

This sequence of deformation is interesting if one considers the variation in the thickness of the plates.

The results of all the tests with plain furnaces are summarized in the accompanying table.

Tests of a corrugated furnace of ½-in. open-hearth steel are shown in Figs. 18, 19 and 20.

The test pieces gave the following results:

	Tensile strength in lbs. per sq. in. Along fiber.	Tensile strength in lbs. per sq. in. Transverse to fiber.	Elongation in 8 ins., per cent.	
Test piece, from end of tube	53,040	53,750	36.7	31.3
Test pieces from place of deformation straightened cold under hydraulic press	74,600	77,100	28.7	28.1
	81,000	75,600	28.0	28.1

After a pressure of 925 lbs. per sq. in. had been maintained for 15 minutes, the deformation occurred which is indicated by dotted lines, Figs. 19 and 20. The pressure fell to 682 lbs. Pumping was continued and the deformation steadily increased. The corrugations straightened out without the appearance of a crack. Two other furnaces gave similar results.

Figs. 21, 22 and 23 show tests of a ribbed tube. The thickness of the plates in the cylindrical part was ½ in. Deformation took place at 855 lbs. pressure, as shown by the dotted lines. Continued pumping increased it until finally the plate tore transversely, as shown.

* Abstracted by W. G. Triest, Jun. Am. Soc. C. E., from the "Zeitschrift des Vereines Deutscher Ingenieure."

THE PREVENTION AND DETECTION OF WATER WASTE.

The reduction of water waste through leaky mains and fixtures, which may be effected by simple street inspection with the aid of sound-detecting instruments and waste meters, is but little appreciated in this country, except in a few of the large cities. In England these methods of waste prevention seem to be much more commonly used, judging from a recent paper and discussion before the Institution of Civil Engineers. This paper was entitled "The Prevention and Detection of Waste of Water." It was presented by Mr. Ernest Collins, M. Inst. C. E., and was discussed by some 20 different persons, the discussion occupying more space in the proceedings than the paper.*

Mr. Collins opens his paper with some general remarks regarding the small importance attached to the waste of water by the general public and points out the large additional cost for the construction and operation of works made necessary by simple waste. He next declares himself as in favor of furnishing water on the rental, rather than the meter, system, with rates varying according to the rental value of the property supplied. As this means that meters for individual consumers are not approved by Mr. Collins, he is limited in his efforts to prevent waste to such methods as may be adopted to detect waste, willful or otherwise, and to stop it or prevent it on the start by securing the introduction of good plumbing.

In 1883 the New River Co., which supplies a part of London with water, was required by the Local Government Board to change its water supply to some 22,000 houses from the intermittent to the constant system. The company empowered Mr. Collins to introduce a system of testing and stamping plumbing fixtures, with a view of aiding the consumers in securing good faucets, etc., and at the same time lessening the waste of water. Accordingly the company now tests all fixtures brought to it, and if found satisfactory, stamps them as approved. All such fixtures are taken to pieces, each part is examined, gaged and weighed, and then,

*Proc. Inst. C. E., vol. CXVII., session 1893-4, part III.

Tests by the German Navy on the Resistance of Plain Boiler Furnaces to Collapsing Pressure.

Furnace number.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11. A.	11. B.	11. C.	11. D.	12.	13.
Material	Best quality iron boiler plate.										O. H. steel.				Iron boiler plate.	
Inside diameter, ins.	39.38	39.38	39.38	39.38	39.38	39.38	39.38	39.38	39.38	37.40	37.40	....	....	....	37.40	39.38
											Deformation					
Deformation pressure, lbs. per sq. in.	341	426	426	426	456	640	640	640	782	782	682	725	711	725	1,136	995
Max. permanent change of radius in deformed ring as observed before deformation took place.....ins.	0.0	0.004	0.059	0.004	0.071	0.012	0.008	0.016	0.043	0.031	0.035	0.031	0.031	0.035	1.38	0.028
Pressure at which max. permanent change of radius in deformed ring occurred, lbs. per sq. in.	284.4	355.5	355.5	284.4	426.6	568.8	568.8	568.8	711.0	711.0	639.9	639.9	639.9	639.9	1,066.5	924.3
Thickness of plate in inches:																
Varying between	0.307 and 0.331	0.283 and 0.315	0.295 and 0.331	0.283 and 0.319	0.425 and 0.464	0.413 and 0.452	0.409 and 0.440	0.417 and 0.440	0.425 and 0.456	0.487 and 0.519	0.484 and 0.491				....	0.578 and 0.598
At place of deformation	0.321 to 0.325	0.295	0.305 to 0.309	0.307	....	0.436 to 0.442	0.417 to 0.423	0.423	0.487 to 0.519	0.495	0.468	0.476	0.472	0.476	0.606	0.578 to 0.598
Test of material:																
Limit of electricity, lbs. per sq. in.—along fiber	23,300	25,050	24,100	24,200	....	....	23,300	22,800	21,300	....	....	....	....	....	....	24,900
Transverse to fiber	26,250	29,900	25,650	24,900	....	....	25,700	23,500	22,800	....	....	....	....	....	....	23,500
Tensile strength, lbs. per sq. in.—along fiber	48,600	53,600	59,700	51,100	53,400	59,400	53,600	54,700	49,100	53,100	54,100				56,000	51,400
Transverse to fiber	56,300	60,000	57,000	54,800	52,700	57,500	55,000	54,100	53,400	56,800	52,200				53,500	49,200
Elongation in 8 ins., per cent.—along fiber	27.5	22.0	22.6	23.5	21.3	24.3	24.0	23.5	24.5	27.0	30.0				17.75	19.75
Transverse to fiber	10.5	12.3	10.3	19.5	12.6	18.3	16.6	19.0	1.50	25.0	28.0				10.5	13.5
Length of boiler ring in inches	41.82	29.02	20.16	13.15	77.94	41.9	19.77	28.86	13.15	20.48	27.95	30.32	30.32	27.95	27.40	42.30
Longitudinal seam	Welded at ends; spliced by dble plates central part; 1 row rivets.										Welded throughout.				Same as 1 to 9.	

after being put together, the fixture is tested under a pressure of 300 lbs. per sq. in. Tables of sizes and weights of the parts of the various fittings are furnished to manufacturers by the company and the former have finally come to look upon this plan with satisfaction.

The testing described above is designed to prevent the existence of waste, but it is obvious that waste will occur through fittings not tested or out of repair, through breaks in pipes and from other sources. To detect such losses of water the New River Co. uses the Deacon waste meter, which has been employed satisfactorily at Boston and elsewhere in this country. The Deacon meter is thus described by Mr. Collins:

It consists of a disk working in a conical pipe, in combination with a revolving drum, to which a diagram is attached, worked by a clock, and it registers upon the diagram the rate at which water passes through the meter.*

By a proper arrangement of valves and Deacon meters the total consumption of any district may be ascertained and the approximate waste through broken pipe, defective fittings or faucets constantly running, may be determined from the part of the diagram which represents the average flow of water during the hours from, say, 1 to 4 or 5 a. m., when practically no water is being used. If waste is found in a district one street after another may be cut off at night. Obviously, if the flow drops after a given street is cut out the leak is on that street. The street or streets where waste is occurring having been found, sound-detectors may be employed to follow along the street main to discover leaks, the noise of the escaping water readily lending itself to this end; or a house to house inspection may be made, or both be employed.

The New River Co., Mr. Collins states, takes a diagram once in two weeks from each meter district, and so long as the waste indicated is between six to ten gallons per capita per day no inspection is considered necessary. When the waste rises to ten gallons steps are at once taken to locate it.

The discussion which followed Mr. Collins' paper brought out the fact that similar means of waste detection were quite commonly employed in England and meet with favor. In some places, instead of using meters, the inspectors shut off the water from a district, then open the valve gradually and gage the amount of waste "by the number of revolutions by which the valve was opened when the sound of water was heard to be flowing through. If there was no sound there was no waste." In one place, where water was heard flowing through the valves at one-fourth and in another at one-sixteenth of a revolution, the waste was considered to be so great as to require its prevention.

From the general tenor of the discussion it appeared that many of those participating in it were not in favor of metering water used for domestic purposes, but that water used for industrial purposes was generally metered.

A MATHEMATICAL INVESTIGATION OF STAND-PIPE FAILURES.

By E. C. Murphy.**

The following mathematical investigation of two ways of failure of stand-pipes is new to me, and may be of interest to the readers of Engineering News.

Let us first consider failure from crushing of the plates on the leeward side of a stand-pipe, due to wind pressure when there is no water in the pipe.

Let Fig. 1 represent part of a stand-pipe extending from the top down a distance, x, considered as a free body.

Let l = the height of the pipe.
d = the outer diameter.
R_1 = inner radius.
R_2 = outer radius.
t = thickness of plate.
M = bending moment.
I = moment of inertia.
w^1 = weight per cubic inch of metal.
p_2 = stress per square inch in outermost fiber due to bending.
p_1 = stress per square inch in metal due to weight of metal.

The stand-pipe will act as a cantilever beam. The maximum wind pressure on stand-pipes is usually taken at 30 lbs. per sq. ft. on an area equal to the length by the diameter. We assume it as q, equal to 30 lbs. per sq. ft. on an area xd, where x varies from 0 to l.

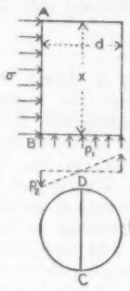


Fig. 1.

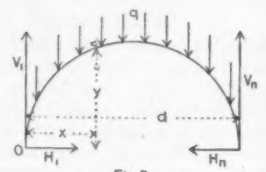


Fig. 2.

Taking moments about the neutral axis C D of Section B, Fig. 2, we have:

$$M = q\frac{d\,x^2}{2} = \frac{p_2\,I}{\frac{1}{2}d}, \text{ or } p_2 = q\,\frac{d^2\,x^2}{4I} \quad (1)$$

$$I = \tfrac{1}{4}\,\pi\,(R^1_2 - R^1_1) = \tfrac{1}{4}\,\pi\,(R_2^2 + R^2_1)(R_2 + R_1)(R_2 - R_1) = \frac{\pi d^3\,t}{8} \text{ approx.}$$

Substituting this value of I in (1) we have:

$$p_2 = \frac{2\,q\,x^2}{\pi\,d\,t} \quad (2)$$

From sum of vertical forces equals zero, we have:

$$p_1\,F = \pi\,t\,d\,w^1, \text{ or } p_1 = w^1\,x \text{ approx.} \quad (3)$$

The greatest stress in the outermost fiber in any section B, for this case of failure, is

$$p_2 + p_1 = w^1\,x + \frac{2\,q\,x^2}{t\,d} \quad (4)$$

Substituting for w^1 and q their values we have

$$p_2 + p_1 = .28\,x + .133\,\frac{x^2}{t\,d} \quad (5)$$

If the maximum allowable stress in the plates is 9,000 lbs. per sq. in. gross section, (5) becomes

$$9{,}000 = .28\,x + .133\,\frac{x^2}{d\,t} \quad (6)$$

From equation (6) we see that t, the thickness of the plate, varies directly with x and inversely with d. The following table gives values of t for a few values of l and d:

	Value of d in feet.					
l.	5	10	15	20	25	30
100	.37	.18	.09	..	..	..
150	.84	.42	.21	.10	..	..
200	1.47	.73	.36	.18	.09	..
250	2.44	1.22	.81	.60	.30	.15

We may next consider the failure of a stand-pipe by its top buckling on the windward side.

From the preceding case we have for the vertical stress on the windward side:

$$p_2 - p_1 = .133\,\frac{x^2}{d\,t} - .28\,x \quad (7)$$

$$\frac{d\,(p_2 - p_1)}{d\,x} = .266\,\frac{x}{dt} - .28 = 0.$$

x = d t approx., that is, the vertical stress on the windward side is zero at a distance t d from the top.

We may, therefore, neglect this vertical stress and consider a strip one unit in vertical length as an arch rib hinged at the ends. Fig. 2 shows such a half ring as a free body. The wind load is qd.

$V_1 = Vn, = q\,R_2$; $H_1 = Hn, = .424\,q\,R_2$

Taking moments about any point, e, we have:

$$M = Hy + q\,\frac{x^2}{2} - V_1\,x$$

$$= .424\,q\,R_2\sqrt{2\,R_2\,x - x^2} + q\,\frac{x^2}{2} - q\,R_2\,x \quad (8)$$

To find the position of the maximum moment we have

$$\frac{d\,M}{d\,x} = \frac{.424\,q\,R^2\,(R^2 - x)}{\sqrt{2\,R_2\,x - x^2}} + q\,x - q\,R^2 = 0 \quad (9)$$

Solving (9) we have

$$x = R_2,\ 1.905\,R_2 \text{ and } .095\,R_2.$$

Substituting $x = R_2$ in (8) we have

$$M_o = -.076\,q\,R_2^2 \quad (10)$$

Substituting $x = 1.905\,R_2$, or $.095\,R_2$ in (8) we have

$$M_1 = .090\,q\,R_2^2. \quad (11)$$

Equation (11) gives the value of the maximum moment. The thrust along this rib is $\frac{H}{F}$ at the crown and $\frac{V_1}{F}$ at either abutment. This thrust is small and may be neglected. For $F = \frac{1}{4}$ in. and d = 25 ft. it is 125 lbs.

$$M = \frac{p_2\,I}{\frac{1}{2}\,t}, \text{ or } p_2 = \frac{t}{2}\,\frac{M}{I} \quad (12)$$

Substituting for M, I and q their values in (12) we have

$$p_2 = \frac{t}{2} \times \frac{.09 \times 30}{144} \times 12\,\frac{R_2^2}{t^3} = .1125\,\left(\frac{R_2}{t}\right)^2 \quad (13)$$

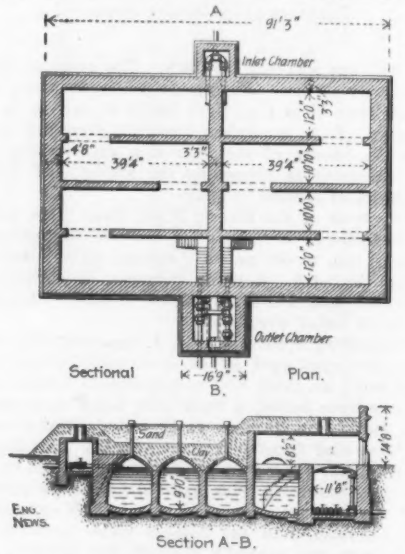
If p_2 be put equal to 20,000 lbs. per sq. in. (13) becomes

$$20{,}000 = .1125\,\left(\frac{R_2}{t}\right)^2, \text{ or } \frac{R}{t} = 421.6 \quad (14)$$

Formula (14) gives the thickness of the unstiffened top plate in terms of R_2. For $R_2 = 5$, 10, 15 and 20 ft., t = .145, .290, .436 and .581 ins., respectively.

A COVERED RESERVOIR AT FUENFKIRCHEN, TRANSYLVANIA.

The city of Fuenfkirchen, in Transylvania, obtains its drinking water by gravity from two springs in the limestone mountains, near the city. One of the springs and a small high-service reservoir have been covered. The accompanying plan and section show the reservoir, with its roof. It contains two chambers of a capacity of about 130,000 gallons each, with walls and openings de-



Section A-B.

Covered Reservoir at Fuenf-Kirchen Transylvania.

signed to cause a thorough circulation of the water, as shown in the illustration. The walls and the arched roof of the reservoir are built of Portland cement concrete, and the walls are finished with a coating of neat Portland cement mortar, extending up to the water line. Cut stone is used for the portal and for cornices, window and door frames and stairs.

We are indebted to the "Journal fuer Gasbeleuchtung und Wasserversorgung" for the matter from which our illustrations and description are prepared.

REBUILDING THE PENNSYLVANIA R. R. AFTER THE FLOOD OF 1889.*

The storm developed in Pennsylvania on May 30, 1889, when flooding rains commenced in the vicinity of Johnstown, gradually extending over the entire state as far east as Lancaster, and continued almost without cessation for a long period of 24 to 36 hours. During these periods from 4 to 8 ins. of rain fell in localities which were below the general level, and from which it is evident that a greater quantity must have fallen on higher districts and mountain ranges. This vast amount of rain falling on an area of over 12,000 sq. miles, caused the most destructive flood known in the history of the country. On May 31 I was, during the greater part of the day, with three companions driving

*In Eng. News for Dec. 11, 1880, was given a more extended description of this meter and its use.

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*Abstract of a paper read at the convention of the New England Roadmasters' Association, at Boston, Aug. 15, by Mr. Jos. T. Richards, Engineer of Maintenance of Way, Pennsylvania R. R.

across the country for professional observations between Middletown and Hummelstown, near Harrisburg, Pa., where the water gage registered a rainfall of 8.2 ins. I started west from Philadelphia early on June 1, with Mr. Frank Thomson, First Vice-President, under directions to repair our losses. Before arriving at Harrisburg we found the tracks under water for almost 1½ miles between Steelton and Harrisburg, but we managed to get our train through, the water being over the boxes of the car wheels.

Finding the water was still rising, we stopped at Harrisburg to learn the situation and make arrangements for the emergency. Here we immediately started to prepare a complete outfit for work, feed and camp the carpenters, telegraph linemen, laborers, etc., using what we might find about us as available. We changed two baggage cars into kitchen cars, purchasing and placing a cook-stove at each end, making tables and benches for the conveniences of the cooks, and laying in a large supply of provisions. We also purchased a supply of table and cooking utensils for a strong commissary department, at the same time taking the seats out of the passenger cars and making a table of pine boards the full length and down the middle of each car, placing one of these cars at each end of a double kitchen car. This formed one of two sets of kitchen and dining cars for the commissary train. A second equipment of this kind was ordered to follow, which was promptly made and came on after we had left Harrisburg. Day coaches were taken, in which temporary sleeping accommodations were arranged, with two blankets supplied for each man.

We also arranged one car loaded with tools and materials for carpenters and trackmen, such as two or three coils of 1-in. and 1½-in. rope, 1,000 ft. each, about 50 kegs of 6-in. and 8-in. cut and boat spikes for bracing and scaffolding; additions to the carpenters' tools, as they were found to be short, and to supply what additional carpenters we would be likely to pick up without tools; several carloads of 3-in. plank, and 12 × 12-in. or 10 × 10-in. lumber, which applies so well for trestling, and as much of our standard stringer sizes as could be found was purchased and arranged for to follow us.*

We also succeeded in finding an electric car on the Cumberland Valley Ry., fully equipped with generators, wires, etc. (Eng. News, Aug. 23, 1890.) This car was manned and taken along and proved to be of great service to turn darkness into light at the Montgomery bridge, and afterwards at the viaduct on the Pittsburg division.

During all this preparation at Harrisburg for materials, tools and commissary department, the water was rising rapidly in the Susquehanna River, and I was suddenly informed by Mr. Thomson, who was managing the line where it could be reached by telegraph, that a passenger train had stuck in the high water between Harrisburg and Steelton. I immediately started eastward to relieve it; first by an engine, but was only able to go a short distance. I then secured a boat, and after proceeding about 1½ miles down the track, it was reached. The trainmen had proved their value in an emergency by securing a large float of logs and boards, and with this landed the passengers in safety on the shore a few hundred feet away, excepting the express messenger, who had valuables in his iron box and was guarding it in the car. I conveyed him, with the iron box, in our boat to Harrisburg station. When we left the train the water was level with the floor of the express car. We then proceeded to Sunbury.

The difficulty in working in swift water at considerable depth can be imagined when it is understood that an inch gas pipe was repeatedly broken off by the current in our effort to get the depth by forcing it to the bottom; and we made the soundings for the first trestle by tying two bars of pig lead together and making a strong cable of twisted telegraph wire, bracing it to the water line. We thus succeeded in getting to the bottom; not in a straight line, of course, but by making allowance, it proved reasonably satisfactory to get the proper lengths for the legs of our trestle bents. The bottom of the river was found to be so rocky and uneven that it was necessary to make soundings for each leg of a bent, so as to fit the bottom, and locate the trestle well enough to carry the heavy trains. We thus found it a most difficult undertaking; besides, we had no labor or material within reach of the north end of the bridge, and but a single track, and no sidings at the end at which we were working, upon which to shift trains or receive the material we were bringing for the hurried undertaking. On June 4, the second day of our forces being at the bridge, we were able to get the first bent in place, upon which we spiked 2½ tons of old railway iron to sink it through the current to the bottom. We had placed our electric car immediately at the south end of the bridge and extended the wires so as to give us light during the night.

*A table of sizes of stringers for emergency trestling, as used on the Western New York & Pennsylvania Ry., was given in our issue of July 5.

During those first two days we laid nearly two miles of additional track and sidings, with switches for receiving the large amount of material and shifting cars which had to go back and forth. We had also succeeded in getting a large number of boats, and as soon as the river could be crossed by boatmen, started a method of hauling framed material in wagons about three-fourths of a mile up-stream, nailing together a raft at the water's edge and boating it across with a heavy force of boatmen to reach the other side, so as to be able to work from both ends.

On June 5 the water had fallen until it was 17 ft. deep, and we were successful in adding to our fleet a small steam ferry boat, discovered at Northumberland, which assisted us very much in ferrying the framed stuff across the river to the north, at which time we divided our carpenter force and worked from both ends and can be said to have been fairly under way by daylight of June 5. The total length of the bridge of eight spans is 1,242 ft. 5½ ins. About 1,000 ft. had to be trestled, 800 ft. continuous, 200 ft. in part. This work was completed and the first train passed over about dusk on Saturday, June 8. The time of raising the bridge was from June 5 at 8 p. m. to June 8, 3½ days; the progress made being about 300 ft. per day.

Our standard trestles, with wooden stringers, are usually limited to 12½-ft. span; but these trestle bents were placed 15 ft. apart, although constructed without a sill. Upon this was turned the very heavy traffic of all main line trains, which first opened out through this as the only channel, and continued under almost a constant roll of wheels for some weeks until the Juniata bridges were built between Tyrone and Harrisburg, and continued quite satisfactory until an iron bridge was ordered.

The 15-ft. span was decided upon to save time, but not until after a serious consideration, and investigation as to the nature of the river bottom. The washed-out spans were 158 ft. in length; a 12-ft. span would have taken twelve bents for one opening, while a 15-ft. span would take but nine bents for one opening. We thus saved three bents at each span of the bridge and opened the road for traffic more than one day earlier by adopting the long-span method.

In a very short time after the traffic was opened, our carpenters had all their tools loaded, and such material as we thought would be worth taking along to be used elsewhere, and we were assembled ready to move westward to the Pittsburg Division. Arriving at South Fork and the viaduct in the flooded district along the Conemaugh valley, we there joined Mr. T. N. Ely's shop force in the reconstruction, and continued until meeting the West of Pittsburg forces under Mr. James McCrea, General Manager, at the trestling of Bridge 6. The western force had rendered us valuable aid by coming from that much-isolated end of our division and constructing the trestle work at Johnstown and also at Buttermilk Falls, and at Bridge 6, laying the washed-away tracks about Conemaugh and opening the road west of Bridge 6.

The lineal feet of track which we lost in the four running tracks, exclusive of sidings and yards at Conemaugh and elsewhere, were slightly over 20 miles between South Fork and Johnstown bridge. This amount of rail was entirely destroyed and had to be replaced by new rail. Not only was the track and roadbed washed away, but the rails were bent, broken and a large percentage lost. The embankments were torn away almost completely, from South Fork to Viaduct, a distance of 1½ miles, and at the Big Wash near Bridge 6, where the river reclaimed its old bed, we were compelled at a great expense to put the river back to its former position, making a four-track bank, 14 ft. to 16 ft. in height, for about one mile.

At Buttermilk Falls the four-track embankment was completely washed away, and after a temporary trestle was constructed for the opening of the railroad, it was filled in by dredged material and shovel plowed from flat cars. The tracks at Conemaugh and Woodvale were completely swept away, but the grading was comparatively light and of sand filling except in the neighborhood of the Conemaugh round house, where the embankment was washed away and had to be replaced by filling 6 ft. to 12 ft. in depth. At the bluff east of Johnstown about 1,000 ft. of four-track embankment was washed away and a height of about 16 ft. had to be replaced. At the east end of Johnstown bridge about 1,000 lin. ft. of four-track embankment, 18 ft. high, was washed away, and was filled in.

Thus the work progressed until June 14, just a fortnight after the flood, direct communication was established over the main line from Philadelphia to Pittsburg, and nearly all passenger schedules were re-established and movement of freight traffic resumed with reasonable regularity. At the end of five weeks from May 31 (the day of the flood), all this two and four-track system of railway was reconstructed and opened for traffic with as many tracks as we had before the flood, excepting, of course, single-track gauntlets across high bridges and trestles. All of these were replaced with three-track stone arch bridges as rapidly as practicable.

EAST FLORIDA LAND DRAINAGE.

In connection with the article of Mr. J. Francis Le Baron, M. Am. Soc. C. E., upon the canals and land drainage enterprises of Florida, published in our issue of July 26, Mr. A. F. Wrotnowski, M. Am. Soc. C. E., of New Orleans, sends us some notes on the work done on the east coast of Florida by the Florida Coast Line Canal & Transportation Co. This company, by uniting the various streams adjacent to and generally parallel to the sea coast, proposes to construct a continuous waterway from St. Augustine to Biscayne Bay, near the extreme southern point of Florida, and covering a distance of 326 miles.

This waterway, says Mr. Wrotnowski, is being rapidly constructed under a grant which gives to the canal company 3,840 acres of land for every mile of canal completed. Through the highlands and marsh portions the canal is to be 60 ft. wide on the bottom and 80 ft. wide in the open waters, with the spoil removed well away from these limits. The depth is to be 6 ft. at mean low water throughout.

There will be two locks, 40 × 200 ft. and 16 ft. over the sill, required to pass the divide between the head of Lake Worth Creek and Lake Worth itself, so arranged as not to interfere with the drainage of the Everglades, for which Lake Worth Creek is one of the main drainage arteries. Another lock, with 15 ft. over the sill, will also be constructed in the Haulover Cut, between Indian River and Mosquito Lagoon. This will be required to cut out strong currents created by winds, which pile the water on one side of the lagoon and create a corresponding depression on the surface of the other side.

The accompanying tables show the comparative utilization of waterways for navigation on the east coast of Florida, and also the quantities of material remaining to be handled:

Length of Water-Ways, Natural and Artificial, Proposed to Form Inland Navigation Route on East Coast of Florida.

Sec.	Length ft.	Length miles.	Cuts in solid soil. No.	Cuts in solid soil. Length, ft.	Cuts in solid soil. P.c. of total.	Cuts in open water. No.	Cuts in open water. Length, ft.	Cuts in open water. P.c. of total.	Open water, no work. Length, ft.	Open water, no work. P.c. of total.
1. St. Augustine to Indian River....	501,900	95	7	94,410	18.76	24	85,370	17.01	322,120	64.22
2. Hanlover Canal to Jupiter River.	718,080	136	..	.....	....	27	91,675	12.77	626,405	87.23
3. Jupiter R. to south end L. Worth	153,120	29	8	23,650	15.45	6	12,220	7.97	117,250	76.57
4. So. end L. Worth to Biscayne Bay	348,480	66	8	113,780	32.65	7	31,755	9.12	202,945	58.24
Total, St. Augustine, Biscayne Bay.	1,721,580	326	23	231,840		64	221,020		1,268,720	

Excavation Required to Complete Entire Water-Way on East Coast of Florida for the Florida Coast Line Canal & Transportation Co., from St. Augustine to Cocoa Nut—Biscayne Bay—(326 miles).

	Cu. yds.
Highland soil, shell, clay, loam and sand.....	1,224,451
Coquina shell rock	87,791
Marshes—mud, shell, etc.	1,852,181
Open water cuts—mud, sand and shell.....	1,360,873
Total bet. St. Augustine and Biscayne Bay..	4,525,296*

*At the time this survey was completed (April 1, 1889, there had been excavated about 917,867 cu. yds. in 54 different places included in above estimate.

The boat railway project, for overcoming the obstruction to navigation at the Dalles of the Columbia River, in Oregon and Washington, is provided for in the present river and harbor bill The plan contemplates a hydraulic lift for steamboats and the transportation of these steamboats for thirteen miles on an 8-track tramway around the falls. It is expected that four years' time and $2,000,000 will be required to complete this work. The project was described in our issue of Sept. 12, 1891. The same bill also provides for a canal to connect Lakes Union and Washington with Puget Sound. It would provide freshwater anchorage for ships and would be of general commercial benefit. This project was heartily approved of in a report to the Navy Department made by Messrs. P. C. Asserson, A. G. Menocal and F. C. Prindle, Civil Engineers, U. S. Navy. They recommended it as especially serviceable and useful as a freshwater naval station and harbor for steel ships. Another project is the construction of a lock and dam at the

rapids in the Mississippi River, midway between St. Paul and Minneapolis. This would make navigation to the latter city feasible.

Two drainage canals have recently been completed in the Red River Valley in Minnesota, which reclaim about 250,000 acres of land. The Sand Hill Canal in Polk Co. cost $22,190, which is $40,035 less than the original estimate. It is seven miles long, with a bottom width of 20 ft., and a depth of 3 ft. to 10 ft. In making it 200,364 cu. yds. of earth were excavated at an average cost of 11.075 cts. per yd. The Tamarac River Canal in Marshall Co. cost $20,807, or $34,414 less than the estimate. It is 7½ miles in length, but is shallower than the Sand Hill Canal. The great fall in prices of labor is the reason why the canals were built so much more cheaply than the original estimates. The state drainage commission has voted to at once ask bids for building two canals in Marshall and Norman counties, each of which will be about five miles in length, and the two together will drain about 125,000 acres of land. The state drainage commission was established last year by the legislature. A state appropriation of $100,000 was supplemented by a contribution of $25,000 by the Great Northern Ry. Co. At least ten more tracks of important marsh lands remain to be drained under the commission's direction. Mr. C. M. Miller is the commission's Chief Engineer, and Mr. A. C. Rinehart was the contractor for the canals already completed.

Improvements to the water-works of Minneapolis estimated to cost over $1,000,000 are recommended by Mr. F. W. Cappelen, City Engineer. New pumps, boilers and mains are proposed, also a 93,000,000-gallon storage reservoir and a 30,000,000-gallon mechanical filter plant.

The six principal railway companies doing business in Iowa have petitioned the state railroad commission to revise and increase its schedules of maximum rates now in force. The petition sets forth that the railways concerned have observed the schedules of the board since they were first established in 1888, and that experience has proved that these rates are inadequate and unremunerative. A public hearing on the petition is to be held at Des Moines on Aug. 21.

The power of the later small caliber projectiles for small arms, and the effect of the latest envelope now used on these bullets, can be judged of from experiments recently made by Capt. L. A. La Garde, published in the last report of the Surgeon-General of the U. S. Army. The target was hard oak, fired at against the grain. At 3 ft. from the muzzle of the gun, and with a striking velocity of 2,000 ft. per second, the penetration was as follows with the envelope named:

Copper-covered bullet (230 grs.)	penetrated	3.2 ins.
German silver envelope (220 grs.)	"	5.3 "
Nickel-steel envelope (220 grs.)	"	10.5 "

The first bullet was .45-in. caliber and the two others .30-in. caliber. The nickel-steel jacketed bullet was not deformed at all, while the two others were badly deformed. The bullets themselves were made of pressed lead.

The Jerusalem-Joppa railway is reported as in financial trouble, thus early in its existence. It is now stated that its original promoters were of malodorous fame; that the work cost three times as much as it should, and was turned over to the company in an incomplete state, and many accidents have already resulted. The affairs of this little company are managed by three distinct fully-equipped organizations; one in France, where the money came from; one in Constantinople, to keep things straight with the Turkish officials, and one on the ground, which built and operates the railway. This triple-headed management is not in accord with itself and swallows up profits that should go to the outside stockholders.

The New York Aqueduct Commission has just made a statement of its receipts and expenditures from its creation to June 30, 1894. The total receipts were $28,718,102.45, derived from the following sources:

From bonds issued—	
Amount of bonds	$28,695,000.00
Premiums on same	607,168.70
From proceeds of miscellaneous sales, etc.	15,933.75
The expenditures were as follows:	
Vouchers, pay rolls, etc.	$3,681,603.66
Contracts, agreements, etc.	22,356,595.74
Land and land damages	64,563.07
Commissioners of appraisal—	
Awards	1,904,659.52
Fees of counsels, commissioners, etc.	682,705.87
Total expenditures	$28,690,127.86

Proposals for enlarging Hoffman Island, in New York Harbor, and for laying a 6-in. submerged pipe from Staten Island to Hoffman Island and a 4-in. pipe from the latter to Swinburne Island, will be received until Aug. 24 by the New York State Quarantine Commission, as stated in detail in our advertising columns. There will be required about 105,000 cu. yds. of embankment, 29,000 cu. yds. riprap, 1,163,000 ft. B. M. southern pine timber, 69,000 lbs. of bolts, besides minor items of other material and labor. Mr. Chas. F. Allen, 71 Broadway, New York city, is president of the commission.

Running against buffer stops in entering stations is a comparatively common accident on English railways. On Aug. 12 the Edinburgh express on the Midland Ry. entered St. Pancras station in London; the brakes failed to work properly, and the train ran against the buffers injuring 21 persons, 6 of them seriously.

The Russian "secret process" projectile is now interesting ordnance officers in Europe. At late trials at Ochta, against a tough 10-in. treated steel plate, this shot gave in each case from 10 to 12 ins. penetration; while ordinary shot used in a similar manner was always shattered against the hard skin of the plate. "The Engineer" believes that a false point or cap was used as a temporary wedge to break the skin, instead of allowing the point of the projectile to do this. Captain Tresidder, of the Royal Engineers, was present at the trial and he thinks he has evidence to show that a cap was used, but used rather as a pad to break the shock of impact. In the Ochta trial the spectators were not permitted to inspect the projectile used either before or after firing.

Two 13-in. Carpenter projectiles were tested at the naval proving grounds at Washington on Aug. 14, and they both penetrated 14½ ins. of nickel-steel armor plate, oil-tempered, and 40 ins. of oak-backing, with practically no injury to the shot. The test plate was 12 ft. long and 7 ft. high, with the thickness stated. Two shots were fired at it; the first, weighing 1,100 lbs., was backed by 327 lbs. of brown prismatic powder and the velocity imparted was about 1,400 ft.-sec., with a striking energy of over 12,000 tons. This shot tore off about one-fourth of the plate, split into fragments. The second shot, with a like charge and velocity, completely demolished the plate. When recovered, both projectiles were practically uninjured and were almost in condition for another round. These projectiles taper down to a point almost as fine as the point of a lead pencil; but, as in previous tests, they passed through the armor without even blunting this point, leaving it sharp enough to scratch the finger. The test was pronounced eminently successful, and the projectiles, selected at random from a lot of 60 tons, show a better record for penetration without set-up or injury than any foreign-made projectiles ever tested.

Cement-lined rock excavations for compressed-air storage chambers are used at the Mansfeld copper mines in Germany. The chambers are of bottle shape, closed by brick walls into which the pipes are built. There are eight of these receivers, from 1,235 to 3,950 cu. ft. capacity. It is stated that a rock chamber of 2,200 cu. ft. capacity costs only one-third as much as an iron receiver of equal capacity. These large chambers permit air to be stored in large quantities near the points where it is required, and in the event of a breakdown or stoppage of the compressor for any purpose, the large capacity of the chambers enables the drills and machinery to be worked for several hours before the air is exhausted. The air from these chambers is also cleaner and drier than air drawn rapidly from a small reservoir.

The Mekarski system of compressed-air motors for tramway service has been adopted on three lines in Paris operated by the General Omnibus Co., and these lines are among the most important in their system. The longest runs are from the Louvre to Sevres and Versailles, about 12 miles. The two others run to St. Cloud from the Louvre, 6.3 miles, and from the Cours de Vincennes to St. Augustin, 5.7 miles. Trains of three cars, carrying 51 persons each, will start from the Louvre every 15 minutes. The motor-car will have six wheels coupled and will weigh 18 tons each, as an incline of 1 in 23 has to be mounted on the Serves line. Each of the three cars loaded weighs eight tons. The air-pressure used will be 1,138 lbs. per sq. in., and the reservoirs will have a capacity sufficient for a 12-mile run.

PERSONALS.

Mr. W. W. Strong, City Engineer, of Northampton, Mass., died Aug. 6.

Mr. E. M. Reynolds has been appointed Purchasing Agent of the Lehigh & Hudson River R. R.

Mr. M. E. Gray has resigned the position of Superintendent of the Georgia Midland & Gulf Ry.

Mr. J. M. Carson, for several years Superintendent for the Danville Water Co., died at Danville, Ill., Aug. 6.

Mr. John McGee has been appointed Master Mechanic of the Rochester Division of the Western New York & Pennsylvania Ry.

Mr. C. H. Dearborn has been appointed Chief Engineer of the Calumet & Blue Island Ry., with headquarters at South Chicago, Ill.

Mr. Anecito G. Menocal, Civil Engineer, U. S. N., has been transferred from the Norfolk navy yard to take charge of the dry dock at Puget Sound.

Mr. Geo. W. Wait, who was for some years Chief Engineer of the Pacific Mail Steamship Co., died at Brooklyn, N. Y., on Aug. 11, at the age of 68.

Mr. S. D. Hatch, architect, died at Plainfield, N. J., Aug. 12. He was architect of the Murray Hill Hotel, the Boreel Building, and other important structures in New York city.

Mr. William A. Wampler, of Westminster, Md., died Aug. 11, at the age of 73. He was engaged on a land survey when he was struck by paralysis and died almost immediately.

Mr. Geo. P. Harris has been appointed Engineer of Maintenance of Way of the Lehigh & Hudson River R. R. He was formerly Superintendent of Track, Bridges and Buildings.

Mr. Chas. E. Turner, of Olean, N. Y., has been appointed Superintendent of Motive Power on the Buffalo, Rochester & Pittsburg R. R., vice the late Mr. W. T. Small. He has until recently held the same position on the Western New York & Pennsylvania Ry.

Mr. W. J. Underwood, who has been a Division Superintendent of the Chicago, Milwaukee & St. Paul since 1884, with headquarters at St. Paul, has been promoted to the post of Assistant General Superintendent, made vacant by the resignation of Mr. E. W. McKenna.

Mr. J. F. Hinkley has been appointed Chief Engineer of the Choctaw Coal & Ry. Co., with headquarters at South McAlester, Ind. T., and it is reported that construction between Oklahoma City and South McAlester, 120 miles, will commence on or before Oct. 1.

Prof. S. P. Langley is to receive the degree of Doctor of Civil Law from the British Association for the Advancement of Science. Professor Langley has been Secretary of the Smithsonian Institution since 1887 and was President of the American Association for the Advancement of Science in 1886.

Mr. J. H. Redmon has been appointed Superintendent of Transportation on the Iowa Central Ry., vice Mr. W. H. Voorhies, who has been appointed Assistant Superintendent. Mr. J. P. O'Brien having resigned as General Superintendent to enter the service of another company, the position is abolished.

Mr. Gustave R. Tuska, Chief Engineer of the Port au Prince Railway, and formerly the Bridge Engineer of the Long Island R. R., has accepted an appointment in the Department of Civil Engineering at the School of Mines, Columbia College. He is at present in charge of the construction of the Lonesome Valley Viaduct (near Knoxville, Tenn.), on the Knoxville, Cumberland Gap & Louisville R. R., where solid concrete abutments and pedestals are now being built under his supervision.

Mr. Benjamin Rhodes, "an American electrical and civil engineer," says a Toronto despatch, was found dead in bed in his lodgings, on Aug. 12, with the gas turned on full and doors and windows tightly closed. His death was reported as a case of suicide and his late residence as Niagara Falls. A Mr. Benjamin Rhodes is a member of the American Society of Civil Engineers, and was lately President of the Brush Electric Light and Power Co., of Niagara Falls, N. Y.

The late President Carnot was, as all know, a prominent civil engineer in the earlier part of his career, and his tragic death at Lyons, on June 24, was made the sole topic at the meeting of the French Society of Civil Engineers of July 6. The president of the society was in Lyons at the time, and upon his return to Paris he tendered to Madame Carnot, in the name of the society, the deep sympathy of that body with her in her dire affliction. At the same meeting, among the letters read from foreign engineers was one from Mr. E. L. Corthell, of the American Society of Civil Engineers, to the French society, requesting that it would transmit to Madame Carnot the profound sympathy of the engineers of the United States. The Russian engineers of St. Petersburg and Kiew also sent similar letters to their French colleagues, expressing their deep regrets at the irreparable loss to the French nation and to the profession of engineering.

NEW PUBLICATIONS.

AUGUST MAGAZINES.—The great railway strike is, of course, a leading topic of interest in this month's reviews. The "North American Review" has a symposium upon it, with Gen. Nelson A. Miles, Hon. Wade Hampton, H. P. Robinson, of the "Railway Age," and Samuel Gompers, President of the American Federation of Labor, as contributors. The greatest interest attaches, of course, to what the last writer has to say, since he represents a large body of organized labor. Mr. Gompers practically confesses that the strike was unwise, and in answer to the question, Was it justifiable? he says:

From the standpoint of the employee, No. From

the standpoint of a labor organization having an agreement with an employer whose provisions a strike would violate, No. From the standpoint of the A. R. U., having no agreement with any of the railway companies involved, and expressing the inarticulate protest of the masses against the wrongs inflicted upon any of their brothers, and their yearning for justice to all mankind, Yes, a thousand times Yes.

Mr. Gompers gives a schedule of the changes in piecework rates which brought on the first Pullman strike; but he says nothing as to the prices at which the company was taking car contracts to keep its shops running and its employees at work. Two other articles specially worthy of note in the same magazine are "Resources and Development of the South," by Secretary of the Interior Smith, and "Sea Power of the United States," by Mr. Chas. H. Cramp.

"The Forum" has a most interesting article, by Mr. Isaac L. Rice, entitled "Legalized Plunder of Railroad Properties," and giving a succinct description of the methods by which the Philadelphia & Reading R. R. was bankrupted. Mr. Rice states that if the acts of Mr. McLeod, the late President, are approved by the courts, the following precedents will be established as legal:

1. A president of a railroad company who engages for his own account in a stock speculation may secretly take securities from the company and use them as margin in that speculation, without involving himself in criminal liability.
2. The company has no remedy whatever if the Board of Directors approves the use of certain of the securities taken from the treasury; and if this approval be given, it is immaterial that it be on representation made by the president understating the amount used by him, even if, as in the present case, the amount withdrawn exceeds the amount stated by nearly 50%.
3. The law further implies that the approval of a limited amount of securities withdrawn as "margin" involves the assumption by the company of the entire liability of the accounts to which the margin is applicable, though that liability extend into millions, being in this case over $6,000,000.
4. The company has no recourse against the Board of Directors for creating an unlimited and unknown liability on the part of the company in the manner described.

To sum up:—The assets of a company are entirely within the personal control of the President. He requires no authority from the Board of Directors to sell any or all of the securities of the company, and he may dispose of them at his pleasure. He is not required to pay the proceeds into the treasury of the company or to account for the same; a memorandum to the effect that the money was expended under his direction, signed by the person who says that he expended it, is all that the company is entitled to. He need not state for what purpose the money was expended, and it is of course unnecessary that the Board of Directors should be apprised of such expenditure, or should authorize or ratify it. He is not bound to furnish the company with the receipts of persons who are supposed to have received the money so expended, nor is he obliged to mention their names and the nature of the claims upon which the payments are made.

According to Mr. Rice, this extraordinary exposition of the law was concurred in by the counsel of the Philadelphia & Reading R. R. and its receivers, as well as the counsel of the trustee of its principal mortgages, and also the counsel of three of its reorganization committees. If Mr. Rice's statements are correct, there has been no worse scandal in a great railway corporation since the days when Gould and Fisk worked their sweet will in the Erie company. With this black record and the recent disclosures with reference to Atchison bookkeeping, it is a wonder that any sensible investor dares to keep funds invested in railway stocks or bonds. Two other "Forum" papers which deserve mention here are "Principles Involved in the Recent Strike," by Mr. D. McG. Means, and "How the Bills of Socialism will be Paid," by Mr. Sylvester Baxter.

IMPROVEMENT OF THE CHARLES RIVER: Report of the Joint Board Consisting of the Metropolitan Park Commission and the State Board of Health of Massachusetts upon the Improvement of the Charles River from the Waltham Line to the Charles River Bridge. F. P. Stearns, Engineer. 8vo.; pp. 51; 16 plates and two large folding maps.

The board whose report is given in this volume was created in June, 1893, by the Massachusetts legislature, and rendered its report in April, 1894. It was instructed to "investigate the sanitary condition and prepare plans for the improvement of the beds, shores and waters of the Charles River," between the limits mentioned above, "and for the removal of any nuisances therefrom." Mr. F. P. Stearns, M. Am. Soc. C. E., the Chief Engineer of the State Board of Health, was appointed engineer to the joint board. Messrs. Olmsted, Olmsted & Eliot were employed as landscape architects, and Dr. Robert W. Greenleaf made a sanitary survey of the district in question.

The board recommends the construction of a dam 1,170 ft. long about 600 ft. above Craigie's bridge, at the lower end of the portion of the river under consideration. This dam would maintain the water above it at a constant level of about 2½ ft. below ordinary high tide, thus preventing the exposure of considerable areas of mud flats at low tide, with the accompanying offensive odors. The estimated cost of the dam, which would contain a lock to pass the largest vessels on the river, is $660,000. Improvements along the river front are contemplated with a view of adding to its attractiveness as a residence section and making this stretch of the river, nearly 11 miles in length, a fine water park.

The report is handsomely illustrated with views of foreign water parks and of the Charles River at various points.

DIE LEHRE VON DER BELEUCHTUNG UND SCHATTIERUNG, als Lehrmittel fuer Lehrer und Schueler. (Theory of Light and Shade, a Text-book for Teacher and Student.) By G. Delabar. Herder'sche Verlagsbuchhandlung, Freiburg i. B., 1893. 12mo; cloth; pp. 124; 134 figures on 34 lithographed plates and two woodcuts; $2.40.

This neat little volume forms No. 5 of a series by the same author with the general title, "Instruction in Linear Drawing." The writer commences to treat the subject from a purely theoretical standpoint, beginning with the elementary principles of light and shade, the transmission of light, the position, condition and intensity of light on the object illuminated, the reflection of light, and position of the observer relative to the object. The second chapter is devoted to the geometric principle of light and shade, while chapter 3 treats upon the compound geometric or apparent shade. In the second part of this work the author gives practical hints on coloring and shading of figures in general, demonstrating the practical application of the construction of shadows. The appendix gives the principal facts on colors. The lithographed illustrations are drawn by the author and exceedingly well executed. The branch office of B. Herder, 17 South Broadway, St. Louis, Mo., supplies the work in the United States at the price quoted above.

RAILWAYS IN INDIA.—Administration Report for 1893-94. Part I. By Lieut.-Col. W. S. S. Bissell, R. E., Officiating Director-General of Railways, Simla. 4to; pp. 265.

One of these government reports was reviewed in our issue of June 7, 1894. This latest report shows 489¾ miles built between April 1, 1893, and March 31, 1894, of which 210¼ were of standard gage (5 ft. 6 ins.) and 279½ miles of meter gage. The total mileage is now 18,500 miles, and in addition there are 51¼ miles of steam tramways outside of municipal limits. The average percentage of operating expenses to gross earnings was 47.12%. Particulars are given of the works completed and in progress, and also of lines under survey or projected. One of the most important of the latter is the Cuttack and Calcutta railway, which is to connect with the East Coast Railway, now under construction, and thus afford a coast line between Madras and Calcutta. An iron-lined tunnel under the Hooghly River and car transfer ferries at other points are included in the project. The coal production of the year was 2,529,855 tons. Petroleum is being obtained in Assam.

NEW ROAD AND ROAD LAWS IN THE UNITED STATES. By Roy Stone, Vice-President National League for Good Roads and U. S. Special Agent and Engineer for Road Inquiry, Department of Agriculture. New York: D. Van Nostrand Co. 12mo.; pp. 166; illustrations.

This volume contains much information regarding recent progress in road improvement, from various points of view, but chiefly of a popular character. A number of appendices give the road laws passed in several states. Most of the illustrations show views of either good or bad roads and a few sections through improved roads are given.

STATE BOARD OF HEALTH OF MICHIGAN: Report for the year ending June 30, 1891. H. B. Baker, Secretary, Lansing. 8vo; pp. 346; diagrams and tables.

Like so many other public documents, this report is much belated, but it is only fair to add that an abstract of the quarterly meeting of the board for July, 1894, is already at hand. The work of this board is recognized by sanitarians generally as being very efficient, but the present report contains little of engineering interest. It has a paper on ventilation by Mr. John H. Kellogg, M. D., and extended meteorological records for various places in the state compiled under the direction of the secretary. There is also an elaborate statistical study, by the secretary, of sickness in Michigan in 1890, which contains some interesting observations on the relation between sickness from typhoid fever and low water in wells, the number of cases increasing with the lowering of the ground water.

REFERENCE BOOK OF RAILWAY SECURITIES.—Compiled from official sources by White & Kemble, New York, July, 1894. Cloth; 8vo; pp. 496.

The first edition of this book was reviewed in our issue March 8, and the second edition is practically the same, except that the financial statements, with range of prices of the several securities, have been added for the first six months of 1894. A few small maps of individual systems have been added, a useful feature which may well be developed in later editions, as they show at a glance the position of a railway and its connections.

IOWA SOCIETY OF CIVIL ENGINEERS AND SURVEYORS: Proceedings of the Sixth Annual Convention, held at Cedar Rapids, Ia., June 17 and 18, 1894. Secretary, Seth Dean, Glenwood, Ia. 8vo; pp. 45; illustrated; price, 50 cts.

In addition to the minutes of proceedings, president's address and report of committee on highways and legislation, there are the following papers: "Sanitary Problems," M. Tachirgi; "Paving and Sewerage for Smaller Cities," B. Schreiner; "Coal Mining in Iowa," G. A. Davis; "Improvement of Highways," C. R. Allen; "Cemetery Work," Seth Dean.

WATER-WORKS REPORTS.—The following water-works reports have been received, the names given being those of superintendents unless otherwise specified:

Concord, N. H., V. C. Hastings; Hanover, N. H., Prof. Robert Fletcher, Engineer; Manchester, N. H., Chas. K. Walker; Montpelier, Vt., Joel Foster; Attleboro, Mass., Wm. J. Luther; Boston, Mass., Wm. Jackson, City Engineer; Brookline, Mass., F. F. Forbes; Fitchburg, Mass., A. W. F. Brown, Registrar; Lawrence, Mass., A. H. Sallsbury; Lowell, Mass., Chas. L. Knapp, Secretary; New Bedford, Mass., R. C. P. Coggeshall; Newton, Mass., H. Nelson Hyde; North Andover, Mass., Geo. L. Well, Clerk; North Brookfield, Mass., Shedd & Sarle, Engineers; Springfield, Mass., J. C. Hancock; Taunton, Mass., Geo. F. Chace; Waltham, Mass., Geo. B. Wimslow; Whitman, Mass., J. C. Gilbert; Woonsocket, R. I., B. I. Cook; Binghamton, N. Y., Darwin Felter; Little Falls, N. Y., S. E. Babcock, Consulting Engineer; Poughkeepsie, N. Y., Chas. E. Fowler; Troy, N. Y., Geo. B. Fales, Clerk; Bridgeton, N. J., Timothy Woodruff; Madison, N. J., Jas. P. Albright, Mayor; Bradford, Pa., S. D. Heffner; Erie, Pa., Wm. Himrod, Secretary; Wilmington, Del., J. A. Bond, Chief Engineer; Cumberland, Md., Wm. E. Griffith, Secretary; Richmond, Va., C. E. Bolling; Augusta, Ga., A. H. Davidson, City Engineer; Mansfield, O., F. M. Remy, City Clerk; Bay City, Mich., E. L. Dunbar; Detroit, Mich., L. N. Case, Secretary; Saginaw, Mich., John Weller; Madison, Wis., John B. Heim; St. Louis, Mo., M. L. Holman, Commissioner; Colorado Springs, Colo., Chas. E. Smith, City Clerk.

SOCIETY PROCEEDINGS.

AMERICAN WATER-WORKS ASSOCIATION.—The annual meeting of the association will be held at Minneapolis, Aug. 21 to 23. The following papers are expected and several volunteer papers have been promised in addition: "Niagara Water Power," by E. Geyelin, of R. D. Wood & Co., Philadelphia; "Water Supply and Fire Protection of the World's Columbian Exposition," by W. S. MacHarg, Chief Engineer; "The Kansas City Case Continued," by B. F. Jones, Superintendent National Water-Works Co.; "Socialism and Politics in Water-Works Practice," by L. H. Gardner, Superintendent New Orleans Water-Works Co.; "Private Water Companies in the Province of Ontario," by Willis Chipman, M. Am. Soc. C. E.; "Filtration," by J. B. Rider; "Damage for Appropriation of Streams," by P. D. Wanner; "Wells and Water Supply, New Utrecht, N. Y.," by Wm. D'H. Washington, General Manager Hydraulic Construction Co.; "Analysis of Public Water Supplies with Suggestions for a More Exact and Uniform System," by Prof. Henry Leffman; "Methods of Street Sprinkling and Cost," and "Experience with Fire Protection Lines," by F. A. W. Davis, Treasurer Indianapolis Water Co. Three papers on electrolysis are scheduled, to be presented by Owen T. Smith, A. A. Tucker and C. Monjeau.

Mr. Peter Milne, 95 William St., New York, is secretary, and Mr. Jos. P. Donahue, Davenport, Ia., is president of the association.

MASTER CAR & LOCOMOTIVE PAINTERS' ASSOCIATION.—The twenty-fifth annual convention will be held in Buffalo, N. Y., Sept. 12, 13 and 14, at the Genesee Hotel. A programme of the meeting can be had by addressing Mr. Robt. McKeon, Secy., Kent, O.

COMING TECHNICAL MEETINGS.

AMERICAN ASSOC. FOR THE ADVANCEMENT OF SCIENCE.
Aug. 16 to 23. Brooklyn, N. Y. Secy., W. Putnam, Boston.
AMERICAN FORESTRY ASSOCIATION.
Aug. 20 to 24. Brooklyn, N. Y. Secy., J. D. W. French, Boston, Mass.
SOCIETY PROMOTION OF ENGINEERING EDUCATION.
Aug. 20 to 23. Brooklyn, N. Y. Secy., Prof. J. B. Johnson, St. Louis, Mo.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 1. Secy., O. Von Geldern, 719 Market St., San Francisco.
WESTERN SOCIETY OF ENGINEERS.
Sept. 5. Secy., Thos. Apleton, Lakeside Bldg., Chicago.
NORTHWEST RAILWAY CLUB.
Sept. 11. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept 11. Secy., D. W. McMorris, Burke Blk., Seattle, Wash.
ROADMASTERS' ASSOCIATION OF AMERICA.
Sept. 11, 12, 13. New York. Secy., W. W. Sharpe, Waycross, Ga.
ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 13. Secy., G. W. Shaw, Norton Building.
COMMISSIONERS OF PUBLIC WORKS.
Sept. 19. Buffalo, N. Y. M. J. Murphy, St. Louis, Mo.
AMERICAN WATER-WORKS ASSOCIATION.
Aug. 21 to 23. Minneapolis, Minn. Secy., Peter Milne, 95 William St., New York.
ASSOC. SUPERINTENDENTS OF BRIDGES & BUILDINGS.
October. Kansas City, Mo. Secy., S. F. Patterson, Concord, N. H.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 2 to 6. Bridgeport, Conn. Secy., R. W. Raymond New York.
AMERICAN SOCIETY OF RAILWAY SUPERINTENDENTS.
Oct. 20. New York. Secy., G. A. Hammond, Boston.

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F. P. BURT.....ASSISTANT MANAGER

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The date when the subscription expires is on the address label on each paper: the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

In calling attention last week to the cracking of a concrete reservoir from temperature strains, we stated that few or no similar instances were on record in technical literature. A correspondent writes us that he has reason to believe that the cracking of concrete subjected to extremes of heat or cold is much more common than is generally known. The celebrated aqueduct arches of betoncoignet, near Paris, built some 20 years ago, are said to have failed from this cause, and a masonry river-retaining wall in Berlin is reported to have split on account of contraction in excessive cold weather. Our correspondent adds that these incidents of the failure of engineering works are studiously kept out of engineering literature as a rule—a statement with much truth in it, but which would be improved by adding that it is not the editors of technical journals who study to keep such things secret. On the contrary, it is a special aim of this journal to obtain and publish full reports of all failures of engineering works where the failure teaches any lesson by which its readers may profit. Of course many disasters, to which the newspapers devote much space, are due to causes with which engineers have little or nothing to do. The recent terrible railway accident in Nebraska, caused by train wreckers, is a matter which chiefly concerns those who make and enforce the laws, and little interest attaches to it from an engineering point of view. But where an accident, great or small, reveals some new or little known fact of value to the engineering profession, it is the duty of those acquainted with the particulars to make them known, and for such communications we always have space.

The fallacy of the plea that water consumption should not be checked because the extra flow of water in the sewers is a benefit to health, is well shown by Mr. L. N. Case, General Superintendent and Secretary of the Detroit Water-Works, in his last report. It was found that the health inspectors of Detroit were advising people to let taps run continuously, for the purpose of keeping the sewers clean. Detroit has a combined system of sewerage, and Mr. Case shows that if the city's pumping engines were run at their full capacity of 5,400 gallons per minute, and this amount were discharged continuously into the sewers, the flow would amount to only one-eighteenth the total capacity of the main sewers. While wasted water is a serious addition to the total water consumption, it is practically valueless for the purpose of sewer flushing, since it dribbles in from a hundred house sewers, instead of rushing in large volumes from one pipe. The dribbling waste means little, save a greater dilution of the sewage, and has no effect upon deposits. If a small per cent. of the amount which runs to waste were accumulated in flush tanks and discharged in large volume at intervals, it would do effective work in cleansing the sewer.

A plentiful supply of water is undoubtedly a great aid to good sanitation, but that is merely because of its value in promoting cleanliness. A potable water supply is not furnished for the purpose of turning its flow down the waste pipes; and those who are so ignorant as to keep faucets running on such grounds should be made to pay for such needless waste.

The late successful testr of the 18-in. Harveyized nickel steel armor plates at Indian Head marked an interesting epoch in battleship construction in the United States. This and preceding tests of a most severe character pass about 2,150 tons of armor plate already manufactured, and in a very short time we may expect to see our fast modern battleships afloat fully armed and ready for service. It is just ten years ago (1884) since the U. S. Gun Foundry Board decided upon the use of heavy steel armor on our new ships, and it is seven years since the first contract was made with the Bethlehem Iron Co. for the manufacture of 6,500 tons of armor plate, from 2 to 13 ins. thick. It is only three years since that company set its enormous 125-ton steam hammer, the heaviest in the world, at work forging armor plate. Within these few years we have created gun and armor plants surpassing in essential features the best in the world. We have invented the Harvey process of face-hardening plates, and it has been adopted by nations having years of experience in armor making. Our home-made armor-piercing projectiles are unexcelled for penetration and stability anywhere, and our heavy guns are as good as, if not better, than the best of other nations. This is a very good record for a peaceful nation that about ten years ago was advised, even by some of the foremost of its own lawmakers, to go abroad and buy its warships, guns and armor from nations "that knew how to make them."

It is with much pleasure that we call the attention of our readers to the important and valuable paper in this issue by Prof. Mansfield Merriman, forming the Vice-Presidential address before the Section of Mechanical Science and Engineering of the American Association for the Advancement of Science. The topic chosen, the resistance of materials under impact, is one which is attracting widespread attention among engineers at the present time, and its great practical importance is just beginning to be appreciated. Prof. Merriman's lucid summary of the principles involved in impact will well repay careful study.

We have recently (July 26) discussed this subject editorially; but it seems worth while in connection with Prof. Merriman's paper to call especial attention to two important principles concerning impact, which are not so well understood as they should be. The first is the importance of large mass in the body which receives impact in reducing the strain caused by it, and the second is the importance of an elastic cushion to produce the same effect. Thus a solid floor bridge, covered with ballast, takes up in large part by its inertia the shocks due to the locomotive hammer blow, flat wheels or derailed wheels, and the actual strain which reaches the bridge members is believed to be little in excess of a static strain. Again, the effect of the ties interposed between the rails and the floor must be very considerable in reducing impact, and it is doubtful, for this reason, whether any design of floor for bridges or elevated structures which dispenses with a wood cushion of some sort between rail and floor-beam should be looked on with favor. We may allude in this connection to the experience, in the early days of railway construction, with rails laid on stone blocks for ties. Of course the rails used were then so rough as to cause great impacts, and it was little wonder that both rails and rolling stock were fast battered to pieces. The fact that the substitution of wooden cross-ties in place of stone blocks afforded sufficient cushion to prevent the rapid destruction of rails and rolling stock, however, is good evidence of the importance of such a cushion in diminishing the strains caused by impact.

In theory, we know that a body without mass, absolutely inelastic, and placed on an absolutely inelastic support, will receive a breaking strain from any impact, no matter how small. In practice, of course, no such bodies and no such conditions exist. While extensive experiments are needed to determine more fully the effects of impact, there is much evidence tending to show that the strain produced by impact tends to rapidly dissipate and distribute itself, and that it is a comparatively simple matter to protect structures against excess of strain from this cause.

We briefly noted last week the lesson which is being taught by the experience on the Chicago Drainage Canal, that no greater burden of risk should be placed upon a contractor than he can be held responsible for. Another lesson which is being most effectively impressed is that it always pays to determine as closely as possible just how great are the difficulties in the way before starting an important work. It seems incredible that such an important piece of work as the drainage canal would be put under contract without determining by actual digging just what material had to be excavated all along the line. Yet we understand that such was the case, and that this is the reason why the tough conglomerate hardpan was not discovered until long after the contracts had been let and considerable work had been done. The facts in the case we understand to be as follows: When the first Board of Trustees assumed control of the affairs of the sanitary district of Chicago Mr. L. E. Cooley, its Chief Engineer, laid thorough plans for carrying out a system of surveys and investigations which should serve as a basis upon which to make estimates and let contracts. These plans provided, among other things, for the sinking of a number of test pits to determine exactly the character of the material to be excavated at different points along the line of the canal, which he well knew could not be accurately determined by the ordinary small borings. Hardly had this work begun when a cry arose from the public against what it considered the useless and unnecessary delay which this work would entail in beginning the construction of the canal. Obedient to the popular clamor, the Board of Trustees sent a protest to the engineer against carrying this work any further, and despite all his arguments to prove the importance of ascertaining the exact nature of the material so that no mistakes might be made in its classification and in the estimates of the cost of excavation, the protest prevailed and the test pits were never sunk. Those who have followed the history of the canal will recall how violent was the clamor to have actual construction go on at once, and what an outcry was made against "spending so much time and money on engineering work." Nor is this the first important public work in which those in charge have pursued the penny wise and pound foolish policy of refusing to spend money for engineering investigations and pushing ahead with incomplete knowledge of the work before them.

Following Mr. Cooley's resignation as Chief Engineer, it will be remembered that change succeeded change in this office with kaleidoscopic rapidity. The important question of the route to be followed was not fully settled until about the time that the contracts were let, and then it transpired that all parties were in total ignorance of the existence of the tough hardpan overlying the bed rock, which has caused so much trouble, and which would have been revealed had a few hundred dollars, even, been expended in test pits. In a report recently made to the Board of Trustees Chief Engineer Isham Randolph says:

The borings indicated glacial drift. The pits which

we have lately sunk upon this section also disclose glacial drift, the difference being that the more elaborate and reliable investigations recently made disclose the fact that the material to be excavated is of a more difficult character than was indicated by the simple borings. Both sets of investigations point to the same classification, but only the latest shows the real difficulties to be encountered.

It is to be wished that some of the newspapers which are making so much clamor over the difficulties between the contractors and the Board of Trustees might have the grace to remember that it was chiefly newspaper hubbub that prevented the making of proper investigations by the engineers prior to the beginning of the work and thus caused the very difficulties for which these newspapers are now so industriously laying the blame on all heads but the right ones.

We alluded recently to the influence which the present era of low prices should have in stimulating work on municipal improvements, etc. A gratifying indication that this influence is having its effect, and that, despite the current cry of "business stagnation," no small amount of new work is going forward, is the extended space occupied by proposal advertisements in our columns from week to week. Taking as an example our last week's issue, we find proposal advertisements from the cities of Chicago, Ill.; Toronto, Ont.; Providence, R. I.; Rochester, N. H.; Aberdeen, Md.; Cicero, Ill.; Jamestown, N. Y.; Washington, D. C.; Springfield, O.; Kittanning, Pa.; Fairfax C. H., Va.; Cambridge, Mass.; Morganfield, Ky.; Plainfield, N. J., and Blair, Nebraska; also from the offices of the U. S. Corps of Engineers at Pittsburg, Detroit, Chicago and Wilmington. At a rough estimate, these pending contracts, advertised in a single issue of this journal, involve an expenditure of $1,500,000 to $2,000,000; and, as shown above, the list comprehends public works to be undertaken in no less than 16 different states.

It is of interest to note in this connection that Engineering News was the first journal of its class to compete with the metropolitan dailies in the publication of proposal advertisements. It has been the work of years to make city officials aware of the fact that it is vastly more beneficial to them to advertise pending contracts in a journal which reaches nearly every contracting firm of importance in the country than it is to place the same card in a newspaper, where not one reader in ten thousand will notice it. But that work has been in great measure accomplished, and the steady and increasing patronage is the best of evidence that the results obtained from such advertise ments are highly satisfactory.

There is one question in connection with the advertisements for proposals which is worth especial discussion, and that is why do private corporations do comparatively little advertising in letting contracts? We believe it is largely because the advantages of bringing work to the knowledge of a large list of contractors are not fully recognized. It is true that many contracts given out by companies are now advertised in our columns; but the number is far from being what it should be, and what we believe it is destined to become. It may be said that one reason why municipal officers advertise pending contracts so much more freely than officers of private corporations is that the law compels them to do so. It is doubtless a fact that the laws on this matter have had much to do with leading municipal authorities to advertise their contracts; but on the other hand we believe that the advantages resulting from such advertising are now so well established and understood, that were all laws on the subject to be repealed, the practice would be continued by all honest and intelligent city officials.

It is to be remembered, moreover, that in many of the great private corporations of the present day, the managing officers occupy positions of trust quite as truly as those who hold public office. The opportunities for profit through abuse of this trust, especially in the letting of contracts, are very great, and it is coming to be realized that the best safeguard of stockholders and bondholders is to require entire publicity in the management of the corporation's affairs. It is a gratifying sign that the patronage of our proposal columns by companies, though small compared with the work advertised by municipalities, as already stated, is steadily increasing.

THE COMPARATIVE COST OF MECHANICAL FILTERS AND SAND FILTER BEDS.

Numberless bacteria have doubtless been swallowed by the good people of Providence while the city officials have been balancing the merits of mechanical filters and sand filter beds, but the results of the investigations and discussions which have been going on meanwhile may in the long run more than compensate any damage done to the citizens and are also likely to prove of value to the whole water-works fraternity. Elsewhere in this issue there is added to the information given in Engineering News of June 28 and July 19 some correspondence, both on the local situation and on the cost and operation of sand filter beds in this country and abroad. The correspondence started with a letter addressed to this journal by Mr. S. L. Morison, Vice-President of the Morison-Jewell Filtration Co., in reply to the report in our issue of July 19 by Mr. J. Herbert Shedd, M. Am. Soc. C. E., City Engineer of Providence, advocating filter beds and giving their estimated cost as about $200,000, against $281,000 for a mechanical filter plant. Mr. Morison questioned the fairness and reliability of Mr. Shedd's figures, and seemed to challenge the latter at several points. In support of his allegations regarding the cost of filter beds for Providence Mr. Morison made certain statements in the form of quotations and otherwise regarding the filter beds at Poughkeepsie, N. Y., and Nantucket, Mass., to which is was thought that Mr. Charles E. Fowler and Mr. William F. Codd, superintendents respectively of the water-works named, might wish to respond. Proofs of Mr. Morison's letter were, therefore, sent to Messrs. Shedd, Fowler and Codd, in order that any replies which they desired to make might be printed in the issue containing Mr. Morison's letter. Each of these gentlemen availed himself of the opportunity offered, and their several communications will be found following Mr. Morison's letter.

Before taking up these letters it may be well to state that mechanical analyses of sand at the site of the proposed filter beds at Providence have just been made by Mr. H. W. Clark, of the Lawrence Experiment Station, who states that the sand is suitable for filtration at the rate of 2,000,000 to 3,000,000 gallons per acre, and that it is similar to the sand used at the filter beds at the Lawrence water-works (described in Engineering News of Aug. 3, 1893). This rate of filtration is as high as has been counted on, and the fact that sand can be found at the site of the proposed beds is greatly in favor of a low cost of construction.

As to the various points in the four letters, little comment is necessary. So far as Providence is concerned only estimates are presented on each side and the reader may judge for himself which estimate is most reliable and whether Mr. Morison or Mr. Shedd is best able to tell what is required in the way of a sand filter bed plant.

Regarding Mr. Morison's figures for the cost of sand filter beds in actual construction in this country and abroad, some of them appear to be in error, as compared with the best figures which we can find. The Poughkeepsie beds, as Mr. Fowler states, originally cost at the rate of about $113,000 per acre, while Mr. Morison gives about $135,000. Possibly Mr. Morison has added something to the original cost for improvements made since the beds were put in operation. Mr. Codd's deduction for the cost of pipe at Nantucket is hardly admissible, since this was made necessary, as we understand it, by the use of a filter, but the full cost of $4,800 for 4,600 sq. ft. of filtering area is at the rate of only $45,450, instead of $55,702 per acre. Here again it may be that Mr. Morison allowed for some extras not included by Mr. Codd.

Comments on the cost of European filter beds will be plainer after quoting from the paper by Prof. Sedgwick, which Mr. Morison gives as authority for the cost of open filters at Berlin and Warsaw. In this quotation we have computed and inserted the cost per acre of the filter beds mentioned. Prof. Sedgwick says:*

> In his recent paper, Lindley has made valuable statements concerning the cost of construction of filtering plants. He gives especially the cost in Berlin and Warsaw, and concludes with the following facts: Estimates carefully corrected give for a large establishment of covered filters having 48,000 sq. meters (11.9 acres) of filtering area in round numbers 67 marks, or 84 francs ($16.75) per square meter ($68,000 per acre). A similar computation for open filters with the same materials and the same price for labor showed that these would cost about 45 marks, or 56 francs ($11.20) per square meter ($45,000 per acre); that is, two-thirds as much. The covering of filters thus means on the Continent an increased cost of 50%. Lindley quotes the actual cost of the Berlin filter at Stralau (2.2 acres covered and 6.8 open.—Ed.) at 64 marks ($65,000 per acre), and at Zegel (all covered.—Ed.) at 68-72 marks per square meter ($69,000 to $72,000 per acre). He cites early English experience as indicating a cost of $10-13 per square meter ($41,000 to $53,000 per acre), everything included.

Mr. Morison's figures for the cost of various filter beds are given below with a column added at the right containing the above figures by Prof. Sedgwick, Mr. Fowler's and Mr. Codd's costs of the Poughkeepsie and Nantucket beds, and such additional figures as we have been able to secure:

Cost of Sand Filters per Acre.

	Mr. Morison.	Revised list
Covered.		
Berlin	$83,000	$69,000 to $72,000
Warsaw	83,000	....
Zurich	88,374	....
Estimate for the Continent		68,000
Open.		
For Berlin or Warsaw (see Prof. Sedgwick's paper)	$55,720	$65,000*
London, from	49,750	....
to	64,675	....
Early English beds		41,000 to 53,000
Estimate for the Continent		45,000
Zurich	58,916	....
Poughkeepsie, N. Y.	134,971	113,000
Nantucket, Mass.	55,702	45,000
Hudson, N. Y., new beds(probably under)		45,000
Ilion, N. Y.		101,000
Lawrence, Mass, under		30,000

*For Berlin alone, but these beds of nine acres' area given as open by Mr. Morison have 2.2 acres of covered area.

There is no clue to the source of Mr. Morison's cost of European filter beds except the words "(Prof. Sedgwick's paper)" in the table. It will be noticed, however, that Mr. Morison's figures agree with none of Prof. Sedgwick's, except that the cost of covered filters at Zurich is given as exactly 50% and the Berlin at about 50% greater than of the open beds at the same places, thus following the ratio corresponding to that of the estimated cost of a large plant on the Continent. In addition the ratio between the extremes of cost given for the London beds is practically 10 to 13, corresponding to the ratio of the range of cost of "early English experience." Curiously enough, although reference is made to Prof. Sedgwick's paper, as authority for the cost of the covered beds at Warsaw, the latter gives no figures for Warsaw, merely stating that such figures have been given by a European writer. Again, strangely enough, the cost of the figures for covered beds at Zurich agrees almost exactly with the approximate figure given in our issue of July 12 for the filter beds and a part, but not all, of the accessories, but Mr. Morison's cost for the open beds, instead of corresponding with the figures given by us, bear the ratio to the cost of the closed filters given by Prof. Sedgwick for large Continental filters. As was pointed out in our issue of July 12, the cost per acre of the Zurich filters cannot be given satisfactorily, since the total cost includes land, elaborate piping and other accessories designed for filters not yet constructed. On the other hand, the figures given by Mr. Morison for Zurich, after making allowances as just stated, are still too low for comparison with the others, since they do not include some of the essentials of the plant. The cost of the Zurich filters was very high, so high that a liberal deduction on account of land and construction for filters not yet built would still leave a figure in excess of any costs of actual beds cited by Mr. Morison.

As a matter of fact all figures for the cost of foreign filter beds have less bearing upon the question than would appear, as it is well known that many classes of engineering construction cost much more abroad than in this country. Moreover, with the exception of the Lawrence plant, all the American filter beds discussed above have areas of less than three-fourths of an acre, the smallest one, Nantusket, having an area of only 4,600 sq. ft., or a little over one-tenth acre. The Poughkeepsie bed has an area of only 0.672 acre and was built over 20 years ago on an unfavorable site, with sand brought from New Jersey. Doubtless it could be duplicated at far less than its original cost.

A word may be said regarding the cost of operating the Poughkeepsie beds, more especially as to the extra cost of pumping necessitated by filtration

* Proc. N. E. W-W'ks Assoc., vol. VII., No. 2.

The clear water basin at Poughkeepsie is some 20 ft. above the main pumps and connected directly with them, so that the filter pump causes an effective reduction in head of about 16 ft., or, in other words, the filters necessitate about 4 ft. extra pumping, which neither Mr. Fowler nor Mr. Morison seems to have taken into account.

In the foregoing discussion the chief object has been to point out probable errors or misconceptions where not already noted in the several letters and to add such slight information as is possible. In conclusion, it may be said that the great difficulty encountered in discussing the relative merits of mechanical and slow sand filtration is the lack of strictly comparable data for the cost of filter beds and the practical absence of all figures for mechanical filters. The particular mechanical filter in which Mr. Morison is interested is in operation in a number of cities, yet he does not present one figure regarding the actual cost of the mechanical filter plants built by his company, but does give the cost of a number of filter beds.

LETTERS TO THE EDITOR.

THE RELATIVE ESTIMATED COST OF MECHANICAL FILTERS AND SAND FILTER BEDS AT PROVIDENCE, R. I.

SIR: In your issue of July 19 is contained a report of Mr. J. Herbert Shedd, M. Am. Soc. C. E., and city engineer of Providence, R. I., "with special reference to the relative efficiency and cost of mechanical filters and of sand filter beds," purporting to consider "the whole subject on its merits."

Mr. Shedd's figures are erroneous and misleading. They are not based on the merits of a fair comparison, and for the natural filters proposed by him, lack all details of cost, with which he has so exactingly encumbered his assumed figures for a mechanical system.

The experiments conducted with mechanical filters at the Pettaconset pumping station for about one year were to demonstrate their efficiency under the rate of filtration for which they were designed by the builders, namely, 128,000,000 gallons per acre per day of 24 hours, including the time occupied for cleansing the filters. It was the superior results obtained at the above average rate, in competition with the sand filters of Mr. Shedd's design, which led to the ultimate selection of the mechanical method. The original recommendation of the special joint committee appointed by the city of Providence, to examine and report on the pollution of its water supply, advised a filtering plant with a capacity of 15,000,000 gallons per day; the engineering department thought it more prudent to have a reserve upon which to draw in case of necessity, and they, therefore, recommended to the city government an additional appropriation, beyond that already granted, to increase the proposed plant from 45 filters, with a capacity of 15,000,000 gallons per day, to 60 filters, with a daily capacity of 20,000,000 gallons. There was also asked at the same time a sufficient additional appropriation to cover the cost of expensive and elaborate buildings, the drawings of which are in the possession of the city engineer, duplicate machinery of the best type, electrical apparatus, meters, etc., of a character to accord with the other installations of the Providence water-works. The latter portion of the work the city was to do itself.

The contract for the mechanical filter plant proper, of 60 steel filters having a daily capacity of 20,000,000 gallons, erected in a building to be furnished by the city, was awarded for the sum of $121,000, or a rate of $6,050 per million gallons capacity, and Mr. Shedd carefully fails to explain to the public that the cost of the filter plant, per se, is not $281,000, as he allows to be inferred, but $121,000, as above stated.

The estimates for buildings, material and supplies, aside from the filters, for which the total appropriation was asked, were as follows:

Buildings and brick stack	$60,000
Extension of water mains with 48-in. pipe to provide for the future growth of the city, a 48-in. conduit leading from the filters to the reservoir, and the necessary piping to and from the filters	35,000
Shafting, friction clutches, gearing, pulleys, belting, etc.	8,250
Valve and wheel stands	5,000
Engines in duplicate	3,000
Boilers in duplicate	3,000
Pumps in duplicate	1,500
Steam heating	1,000
Plumbing	500
Installation of chemical plant	3,750
Feed pumps and heaters	650
Tools for engine room	925
Raising of stand-pipe	1,100
48-in. and 20-in. Venturi meters	3,075
Installation of complete electrical plant	4,475
Total	$131,225
Filter plant	121,000
Total	$252,225

At the meeting of the Providence city council on June 4, 1894, Mr. Robt. E. Smith, Commissioner of Public Works for the City of Providence, made this statement:

A special committee was appointed over a year ago to take into consideration the matter of filtering the city water by mechanical gravity filters. The work was first carried on under the direction of Mr. Shedd and Dr. Chapin, and subsequently, under the supervision of Mr. Weston, who has carefully submitted one of the best reports on the subject ever gotten out. It was our intention to build 45 filters for $100,000, which it was thought would do all the work, besides a wooden building for $30,000, but in the judgment of the committee it was deemed advisable, if we are to have a plant, that we should have one which would be not only enough for the present time, but for all time to come.

Pumping engines, boilers, feed pumps, heaters and tools, must be furnished whether for a natural or mechanical system, and if meters are desirable, they should be purchased in one case as well as in the other. A fair estimate for a complete 20,000,000-gallon mechanical plant, inclusive of buildings durable, but not extravagant, and including the best of machinery in duplicate, would be $215,000.

A proper basis of comparison is, therefore, what is the cost of a complete natural filter-bed system, having the same daily capacity?

Mr. Shedd says $208,000 is sufficient for a plant of 15,000,000 gallons per day, covering an area of 7½ acres, operated at the rate of 2,000,000 gallons per acre per day; but he does not state, that which is a familiar fact with all engineers who have a knowledge of natural filtration, that one-third of this area must be held as a reserve for cleaning the beds, while the remaining two-thirds are in operation.

Prof. W. T. Sedgwick, Chief Biologist to the State Board of Health of Massachusetts, says, in speaking of the Berlin filters:*

Seven of the ten filters are usually running at once, and serve to furnish the requisite quantity of filtered water. The other filters, three in number, serve as a reserve, and also for use in the summer time, when the life of the filters is shorter. The filters are all covered, and, in order to keep the temperature as low as possible in summer, they are covered with a layer of earth, 40 to 70 cm. (16 to 27 ins.) thick. This layer is covered with grass.

At Zurich, the renewing of the filtering material requires 35 days, exclusive of wasting, and the filtrate must waste 20 days after cleaning.** To make the plant efficient, one-third of the filtering service must be considered as out of use; but Mr. Shedd makes no provision for this. His estimate of $208,000 for an uncovered filter should, therefore, be increased one-third, to an area of ten acres, costing $277,333 for a daily capacity of 15,000,000 gallons, or to 13⅓ acres, costing $369,778 for a daily capacity of 20,000,000 gallons, on which capacity the above cost of a mechanical system is based. Compare with his estimate of $27,733 per acre the cost of other well-known natural filter beds:

Cost of Sand Bed Filters per Acre.

Covered.

Berlin	$83,000
Warsaw	83,000
Zurich	88,374

Open.

For Berlin or Warsaw (see Prof Sedgwick's paper)	$55,720
London, from	40,750
" to	64,675
Zurich	58,916
Poughkeepsie, N. Y.	134,971
Nantucket, Mass.	55,702

The exceptionally low cost of the Lawrence beds, $30,000 per acre, was owing to the fact that they were practically constructed by nature, before work on them was commenced, there being a shoal at this point, which rendered the first cost light. The original estimate of the engineer for these beds of 2½ acres, equipped complete, was only $20,000.

The cost of maintenance of the Poughkeepsie filter beds per 1,000,000 gallons, is estimated by Mr. T. W. Davis, formerly (prior to 1880.—Ed.) engineer and superintendent of the Poughkeepsie water-works, as follows:

Running the water through the beds	$2.50
Water used for washing sand, supplies, etc.	4.13
Total	$6.63

The estimated cost of maintaining the mechanical system at Providence, per 1,000,000 gallons, was $3.62.

Mr. Shedd makes no reference as to the construction of the bottom of his proposed filters. It would be well to know whether or not he includes a water-tight bottom and sides. Says Piefke, the great filter expert:

Suffice it to say that the bottom must be water-tight, and the sides strong enough to support the pressure of the enclosed water. Those at Berlin-Stralaw are laid upon clay (Thom) covered with concrete (Beton).

Mr. T. W. Davis says of the Poughkeepsie water works:

The masonry must be of sufficient strength to stand the weight of the water when the beds are in operation, and also the thrust of the earth, or its backing, when the water is removed. They are filled with water, and at the time of cleaning, the water is drained off; that masonry must be water-tight; it furthermore must be of such a character as to stand the frosts of winter, and in connection with an alternately wetted and dried surface, which gives masonry a severe test.

The present superintendent of the Poughkeepsie water-works, Mr. Chas. E. Fowler, states that they are now losing nearly 25% of their filtered water through leakage. He states in his report for 1890:

Leakage developed in the wall, separating the two beds to such an extent in the early part of the year, that one bed could no longer be cleaned while the other was in use, and it became necessary to employ additional help for cleaning, until the sand was lowered sufficiently to permit the wall to be repaired.

And again, in his report of 1893:

The leakage that has existed in the present beds, from their construction, is increasing, and if it continues will soon necessitate the removal of the entire filtering material, to enable repairs to be made, an undertaking that will require the beds to be thrown out of use two months or more. The additional beds should be in readiness for use at such time. Second, with our single set of open beds, we are too much subject to climatic conditions. These beds cannot be cleaned during a storm of rain or snow, or freezing weather. A fall of a few inches of snow during cleaning stops the work entirely. A heavy shower of rain occurring on a summer afternoon, just as the work of cleaning is nearly completed, and before the water is let on, will frequently undo the work, and necessitate another cleaning.

It would also be interesting to know whether Mr. Shedd's estimate includes the erection of a water-tight wall above high water mark, surrounding the filters, and whether he has provided for the necessary engines, boilers, pumps, electric light plant, sand cleaning machinery and power, and for a bridge across the Pawtuxet River.

Mr. Shedd does not propose to cover these filters. Then why should he insist on the expenditure of $60,000 for buildings to cover a mechanical plant, operating at a velocity of 128,000,000 gallons per acre, when it is unnecessary for those of his own, which he proposes to operate at a velocity of 2,000,000 gallons per acre?

Piefke, "recommends that the reservoir for filtered water should be covered; not only to avoid disturbances through the accumulation of ice in the winter, but especially to exclude light."

Mr. Hiram F. Mills, M. Am. Soc. C. E., and engineer member of the Massachusetts State Board of Health, says:

To obtain as good a result in a cold New England winter, it is necessary to protect the surface of the filter bed, so that it will not freeze. If the sand freezes at the surface, the sewage thaws places here and there, and passes too rapidly through the sand in sections, having less than the whole area of bed; air is partly excluded, and nitrification is checked. A closed shed which will keep snow and wind from the bed will be sufficient covering where the sewage used has the ordinary temperature of 45° F. or more. Unprotected beds treated with such sewage may be expected to have nitrification very much checked, and an increase in organic matter in the effluent, shown by the albuminoid of ammonia amounting to three times the quantity found during the warm months, with a large multiple of the bacteria. If (sewage—Ed.) filters are to be run nearly to their full capacity, they should be protected from freezing.

Mr. T. W. Davis, formerly (prior to 1880—Ed.) superintendent of the Poughkeepsie water-works, says:

The climatic difficulties are quite serious. In winter I have been obliged to take off 300 tons of ice (on an area covering slightly over one-half acre) before I could reach my beds; frequently I have had my beds freeze while I was cleaning them, so that the sand would have to be picked up and thrown out; not only costing a considerable amount, but also endangering the safety of the bed itself. Again, in the summer time, my experience was that when the temperature of the filter bed reached 70° F., the fungus growth, or the growth of algae in the bed, would give what is called by engineers the "pond taste" to the water. The water would be brown in color; that coloring matter we could not take out. When the algae appeared, if the water was pumped into our distributing reservoir, it would affect the entire supply, the entire 12,000,000 gallons. In the fall again, the first frost would give us a woody taste in our water; then in running the beds, it was never possible to tell when the bed was going to fail. We cleaned once a month regularly; but I have seen times when the bed would be working all right one day and in the morning I would get a telephone despatch from the engine house that they could not get a drop of water through. We were washing all the time, but we cleaned only once a month. In 1886 it was necessary to remove the entire body of sand from the beds, because the sediment had permeated the entire mass. I found from the analysis given me by Professor Nichols that I returned to my bed 30% of the organic matter and the other matter which the sand took from the water; in other words, we were not able to so thoroughly wash that sand, but what we would return back again 30% of the impurities that we had taken out. During the process of cleaning, if the men walked upon the beds, they would compact the sand at that point, the same being the case if their barrels were allowed to run upon the beds, and there was a liability of an air blow near where the sand had been compact when they let the water on.

Mr. Chas. E. Fowler, in a report, says of the filter

* "The Purification of Drinking Water by Sand Filtration." Jour. N. E. W.-Wks. Assoc., Vol. VII., No. 2. (Dec., 1892.)

** The material is renewed at Zurich once in 29 months, but the corresponding rate of filtration is from 6,500,000 to 10,450,000 gallons per acre per day, or from three to five times the proposed rate at Providence. See Eng. News, July 12, 1894.—Ed.

beds of Poughkeepsie: "Little or no effect is produced on the color of the water, at any time, by filtration."

The following is an extract from a report of Mr. Wm. F. Codd, superintendent Nantucket water-works, Nantucket, Mass., where a natural filter bed established according to the principles of the Massachusetts State Board of Health, was erected in 1893:

The first analysis of water by the State Board of Health, Aug. 14, 1893, showed the number of anaboena in pond water to be 216,000 per 100 c. c., and in filtered water,3,000,or over 98% removed. We were satisfied with the operation of our filter; but after twelve days' use, complaints of odor appeared in the town, the filtered water being still clear. Two days later, the surface of the sand became crusted over, and almost stopped the flow of water, but it was raked over and broken up and did not clog again. After 22 days' use, the odor being so strong, we ceased using the filter, drew down the water, and scraped the surface, removing about ½-in. in depth, taking off as little as possible. Most of the impurities were in the top ¼-in., though the sand was stained deeper, in some places as much as 8 or 10 ins. We found that the air used in aeration, in passing through the sand, had seemed to gather in places and formed little craters where it came up through the sand, instead of coming up evenly all over the bed. Probably water would find its way down these air passages without much filtering. We used the filter again Sept. 1, several days, but had to give it up, as the odor was so strong. Our tank would be better covered.*

A recent letter concerning the Lawrence filter bed, is as follows:

It is not found practicable to pump 16 and drain and clean 8 hours. The filter should have been made in at least two parts, separated from one another by an impermeable wall, so that one can be cleaned without reference to the other. This would involve the construction of a larger bed, as each part must be sufficiently capacious for the whole supply.

The ice gave much trouble last winter, and it is the intention next to keep the water about 24 ins. above the top of the filter. This means that the intermittent plan will be abandoned, as it would be impracticable to draw off all the water, and it will be difficult to clean, and nitrification will be retarded or prevented. If nitrification and intermittent filtration are, as has been stated, essential for the purification, then the filter bed should be covered, which would add much to the expense. It is to be feared, I think, in the absence of provisions for cleaning the whole bed, organic matter will accumulate below the surface, obstructing the rated flow, and furnishing material for objectionable growths.

Not only will the expense of cleaning the whole depth of bed be very great, but unless the bed is made larger it may at any time be found insufficient, and the water department compelled to draw directly from the river while the sand is being renewed. Some rivers produce more sludge than others, and I think the Merrimac River water is unusually good for natural filtration. In other rivers much more cleaning would be required.

The dissolved coloring matter of the water at Lawrence, does not appear to be greatly lessened by filtration, and I noticed the other day that the water had a woody flavor. A more presentable water can be made by mechanical filtration. Unless the retaining walls of a natural filtration bed are unusually well constructed, the danger of river water gaining direct entrance to the filtered water gallery, without passing the filter, is ever present, and can easily escape detection.

Mr. Shedd with great care, remains silent as to the depth of the proposed filter bed. That now recognized as the proper one by leading hydraulic engineers is 5 ft. Mr. Mills, the American exponent of the natural beds, says:

With filters having 5 ft. in depth of sand, whose finer 10% had maximum grains from 0.1 to 0.2 (0.004 to 0.008 ins.) in diameter, the chemical purification when filtering at the rate of 1,250,000 to 2,000,000 gallons in 24 hours, was satisfactory. Similar results may be obtained with filters having sand 4 ft. deep; with less depths, the purification is less complete.

It is unfortunate Mr. Shedd has not published the results of his own experiments at the Pettaconset pumping station, and the comparative result there secured by his own and the mechanical system. In these experiments he used a filter bed 2½ ft. in depth, and the public would be interested to know with what success he met. The shallow filter beds of Lambeth, Grand Junction and Southwark, London, averaging 2½ ft. in depth, showed a mean average for the year 1891 to 1892, of 319 bacteria per cu. cm. in the filtered water, as against 121 in the filtered water from the Chelsea and West Middlesex, London, supplies, the beds of which have an average depth of 4 ft. 4½ ins. The filter beds at Berlin are 4½ ft. in depth; those at Warsaw, 4 ft; those at Zurich, 4 ft.; those at Lawrence, Mass., 5 ft.

Mr. Shedd has not yet explained what provisions he proposes making for subsiding basins, in connection with his filter plant, by which the intake from the river can be closed, an absolute necessity for Pawtuxet water, as the experience of the city has already shown, or whether such provision is covered by his estimate. Says the noted chemist, Dr. E. Frankland, regarding the metropolitan water supply of London:

The fact that the impurity of the water in the rivers is so largely increased during periods of flood water, renders it of great importance that there should be sufficient provision of subsidence and storage reservoirs to enable the necessary daily supplies to be delivered during such periods, while keeping the intakes closed. Such provision is essential for securing uniformly effective filtration.

The report of Mr. E. B. Weston, M. Am. Soc. C. E., under whose charge the experiments at the Pettaconset station were made, it is much to be regretted, has not yet been published, and accordingly no detailed comparisons between the results of mechanical and natural filtration there obtained can be given; but that this carefully prepared and valuable report was not unfavorable to the mechanical method is vouched for by the following statements made before the city council, by officers of the city who were familiar with the contents of the report:

Q. Mr. Burdick: What percentage is removed by the mechanical process?

A. Mr. Shedd: From 98 to 99% of bacteria, and the color is about half removed.

Q. How much of the organic matter upon which the bacteria live will be removed?

A. Mr. Shedd: Practically the whole.

Q. What advantage has this over the so-called "natural process" at Lawrence? Do they get better results?

A. Mr. Shedd: No, I think not. The results are practically the same.

Q. By Mr. J. M. Kendrick: Does this mechanical filtration meet with your own approval?

A. Mr. Shedd: At first I was afraid that it would not accomplish the work; but the experiments that have been made have convinced me that the system is altogether adequate.

In answer to questions, Dr. Charles V. Chapin, Superintendent of the Board of Health of the city of Providence, said:

The filtration of the water would remove 99% of the bacteria, and it does something more; it removes the suspended and dissolved organic matter of the water upon which the bacteria feed, so that what few of them may get through the filter will die for want of nourishment before the water reaches the consumer. The additional advantages are the removal of algae, etc., and the better color of the water. As to the question of the relative advantages of natural versus mechanical systems, I am strongly in favor of the mechanical filter. It will remove the bacteria fully as well, and it will remove the organic matter much better. Not the slightest trace of what we call "sulphate of alumina" comes through. The effect of the alum-filtered water upon the boilers is not at all injurious, but, on the contrary, beneficial. The mechanical filters are used in as many as 50 American cities, and in some instances have been for many years. I have visited these cities and made inquiries of the health officers as to the result, and have never found any case of disease attributed to the use of the water.

Dr. Swartz, of the Rhode Island Board of Health, said:

He was greatly in favor of the mechanical system of filtration. In the natural filters there is one serious objection; the top of the filter bed must be scraped, as the impurities in the water settle upon the bed, forming a dark, slimy sediment, which clogs up the filter, preventing the free passage of the water. In order to properly clean this, the laborers are forced to walk upon the bed, and the impurities upon their boots from the neighboring barnyards and land thereabouts is thus ground deep into the filters whence comes the drinking water of the city.

Mr. E. B. Weston, M. Am. Soc. C. E., of the city engineer's department, stated:

He had been in charge of the tests for the past 15 months, and that at the start he was prejudiced against mechanical filtration. At the conclusion of the experiments, however, he was very well satisfied with the result. In his opinion, a natural filter plant would cost twice as much as a mechanical plant. These figures were arrived at by estimates, and the total cost of the natural filter plant he gave as $500,000. The cost of covering the bed would, he should say, be about $700,000 (filters included). He said rather remarkable results had been obtained by the experiments at Pettaconset, and everything that could be thought of had been investigated. The results of the experiments have shown that as good results could be obtained as with any system of sand filtration. There were few filters abroad that gave satisfaction, for when they were built bacteria were not considered. The results in taking out disease bacteria had been more successful than those at Lawrence. With water bacteria the results have been about the same.

When Mr. Shedd makes the statement that he can construct an efficient natural filtration system for the city of Providence, with a daily capacity of 15,000,000 gallons, for the sum of $208,000, and maintain it at an annual expense of $4,600 or thereabouts, it will be advisable to carefully compare his plans and specifications with those of painstaking and thorough engineers who have given the subject years of investigation and careful study, and see what probability there will be for further demand on the city government to complete a system so constructed.

Let Mr. Shedd make a fair comparison by presenting his complete plans and specifications for filtering the same quantity of water which is demanded for the mechanical system.

New York, Aug. 7, 1894. Samuel L. Morison.
Vice-Pres. Morison-Jewell Filtration Co.

(Owing to the importance of this subject it was thought desirable to give Mr. Shedd and some others mentioned in the above communication an opportunity to reply in the issue containing Mr. Morison's letter. Proofs were, therefore, sent out and responses by Mr. Shedd, Mr. Fowler and Mr. Codd are given below. Further comment may be found in our editorial columns.—Ed.)

Sir: My father, J. Herbert Shedd, City Engineer of Providence, has been confined to his house for several days by severe illness and he has therefore been obliged to hand your esteemed favor of Aug. 10 to me for reply. He has given me such minutes and data as he has been able, and I give the result as follows:

The experiments made on the plain sand filters were to determine other questions than a comparison between natural and mechanical filtration.

Mr. Morison thought 45 filters enough to filter 15,000,000 gallons per day, but Mr. Weston advised that the rate be limited to 100,000,000 gallons per acre per day, and therefore a bid was invited for 60 filters for the purifying of 15,000,000 gallons per day, but as one-tenth of the filtered water is required for cleansing the filters the effective service of the 60 filters at the rate Mr. Weston found necessary from our experiments was really but about 13,500,000 gallons per day. No such waste is required in natural filtration at the slow rate of 3 ins. vertical depth per hour, which is the rate proposed for the city of Providence. (This is equivalent to about 2,000,000 gallons per acre per day, allowing no time for rest or cleaning.—Ed.)

The buildings were such as were proposed by Mr. Morison. None of the apparatus was required to be better than the ordinary apparatus of the Providence water-works, and similar work is proposed for the natural filter.

The bid of Mr. Morison in exact figures, as summed up in this office, is $280,896, which includes all that is necessary, according to his plans, to take the works as they are and leave them ready to supply filtered water.

No machinery will be required for the natural filter except to connect our smallest engine with the drainage conduit. The meters are necessary for the mechanical plant, because the supply of alum must be closely regulated both to the quantity and quality of the applied water.

The cost of the natural filter is for a plant properly comparable with the bid of Mr. Morison and complete in every respect. The following letter of Messrs. Everson & Liddle is simply a fuller statement of the bid which they made earlier for the work; it speaks for itself in regard to what is intended as to completeness of the work:

(Copy.)
Everson & Liddle,
Contractors.
Providence, R. I., Aug. 7, 1894.

Mr. Robert E. Smith, Commissioner of Public Works:

We propose to build for the city of Providence, at the Pettaconset pumping station, a complete filter plant in accordance with the plans and specifications of the City Engineer, to include the proposed dam across the river; the racks, screens, collecting basin and conduit leading from the river to the filter beds; the six filter beds having a sand area of 150 × 300 ft. each with division walls, conduits and various appurtenances; the dike to protect the beds from floods, including riprapping on the outside; the conduit line from the beds to and across the river and into the present clean water basin; the drainage or suction pipe from the beds to and across the river and connecting with the suction pipe of the small Worthington engine; and to do all other things needed to install the plant designed by the City Engineer from the conditions as they exist to-day at the pumping station, and leave the work in a condition to supply filtered water to the present clean water basin, as proposed by the City Engineer, for the sum of $200,000. Everson & Liddle.

Witness: Geo. W. Tucker.

The area of available sand for filtration as proposed is for six beds, each 150 × 300 ft., or a little over six acres. The rate proposed is for a slower filtration than the best modern practice requires, including all stoppages for cleaning.

Mr. Morison's remarkable building up of estimates for the natural filters will not affect the judgment of engineers.

The bottom is to be water-tight, and it is much below the level of the river, which is to supply water to the filter and thence to the clean basin by gravity.

The dike around the filters is intended to be water-tight. No appurtenances are required that have not been included. The only cover provided for the mechanical filters was that suggested by Mr. Morison.

The water is intended to be 4 ft. over the sand, and this will obviate the slight difficulty met with at Lawrence on account of ice.

The suggestion of Mr. Morison that more has been required of the mechanical filter than of the natural, in the comparison of the two, is not true. No estimate that the annual expense of maintaining a natural filter would be $4,600 has been made nor promulgated, nor has anything been written that ought to be assumed to mean to be such a suggestion.

Your kind letter and offer were appreciated by my father, and he thought such an uncalled-for and misleading article should not pass without some comment.

Respectfully yours, Edward W. Shedd.

Providence, R. I., Aug. 13, 1894.

Sir: I have read Mr. Morison's letter, and noted the references to the filter beds at Poughkeepsie.

In the report of the Water Commissioners of this

* In Eng. News, April 26, 1894, will be found an account of the experience at Nantucket, in which Mr. Codd states: "We have decided that the odor was caused entirely by the high temperature of the filtered water after reaching the collecting well, increased by the heat from the sun on the dome roof." Mr. Codd states in a recent letter that on Sept. 29, 1893, the filter was started again with the water at 54° F. It was run 19 days without any trouble, when the pond became clear and filtration was stopped for the year. The tank mentioned is for storage and has nothing to do with the filter.—Ed.

city, for the year 1872, the cost of the filtering works is given as follows:

Paid for land	$2,000
" contractors	56,702
" for small engine	5,500
" " well	2,000
" " pipe	3,665
" " gates	1,084
" on general account, including office, engineering, legal, inspection, superintendence, materials, and labor	4,744
Total	$75,695

The total filtering area of the beds is 29,300 sq. ft., or 0.672 of an acre, making the cost per acre $112,641, instead of $134,971, as given by Mr. Morison. They are now, and have been for several years, performing a duty equivalent to 6,000,000 gallons per day per acre, three times the rate proposed for the Providence beds.

The site upon which these beds are locatd was a rocky knoll, most unfavorable to economical construction. The side walls are of vertical stone masonry. The bottom is covered with concrete. The principal portions of the sand came from New Jersey, nearly 100 miles distant.

It will be readily understood that where the location admits of earth embankments with natural bottom, and suitable sand close at hand, the cost of construction will bear no relation whatever to the cost of these beds.

For the 13 years that these beds have been under my supervision, 1881 to 1893 inclusive, the total expenditures for all purposes including repairs, purchase of new sand, cleaning beds and washing sand, have been $22,715. During this period 7,716,997,902 gallons of filtered water were pumped to the city, giving a total average expenditure of $2.94 per million gallons.

In comparing this with other methods of filtration there should be no account taken of general supervision, as it would be the same in either case. There can be no proper filtration, of any kind, without it. For the same reason the water used for washing sand should not be considered.

Until the present year, steam for pumping to the beds has been taken from the same boilers that supplied the main engine, and no accurate, separate account of the cost of pumping for filtration could be kept, but it has been estimated at about $3 per million gallons. In our case, however, were mechanical filters to be used, the cost of pumping would be increased, as the only location available would necessitate a higher lift. The cost of pumping should not, therefore, be taken into account in making general comparisons of the cost of the different systems.

The leakage of our beds is a serious defect. I understand that it has existed from the first, but it has materially increased during the past ten years.

The climatic difficulties render the cost of operation much greater than if they did not exist. They would be materially lessened, and almost entirely eliminated in cold weather, if we had the rate of filtration proposed at Providence. The most serious difficulty at present arises from the growth of algae on the surface of the sand in the summer, which has been more rapid and abundant the present season than ever before. The effect of this growth is, simply, to retard or stop filtration. I have never observed that it imparted any taste, odor or color to the filtered water. The growth is not the same in all years. It does not appear to be dependent upon temperature. It was much more abundant in 1892 and thus far in 1894 than in any other years in my experience. Last year it was comparatively light. It is quite certain that this trouble would be entirely obviated were the beds covered. The clear water basin was covered about three years since, so as to exclude light. There has been no growth of algae in this basin since.

I have experienced no difficulty in anticipating the failure of the beds from algae or from changes in the river, but in seasons of large consumption it has sometimes been difficult to store sufficient water in the reservoir to supply the city during the time of drainage and cleaning, and the constant fear is that a prolonged rain or snowstorm may set in at such time and prevent cleaning. It never has occurred, however, in my experience, and we have not, thus far, pumped direct from the river to the reservoir during the 13 years past, and the city has always had a sufficient supply of water, though we have had several narrow escapes.

These beds were completed in 1872 and were in almost constant use until the beginning of 1881. From that time until the present they have been in constant use. The broken stones and gravel forming the lower portion of the beds have not been disturbed since completion. The sand has all been removed, washed and replaced several times, much of it many times, yet analyses made last year show a greater reduction of organic matter in the filtered water than when similar analyses were made in 1877. Yours very truly,

Chas. E. Fowler, Superintendent Water-Works.

Poughkeepsie, N. Y., Aug. 13, 1894.

Sir: Referring to the enclosed proof, I would say that Mr. Morison has drawn an erroneous conclusion from my report on our filter bed.

Our filter bed was built above the level of our pond to save cost of construction. It will probably never be used more than three months in a year, and not every year, because it is only occasionally, in the fall, that our water needs filtering, it being as good as any one could desire the rest of the time. We estimated that the cost of raising the water onto the filter bed—a height of perhaps seven feet—would not be as great as interest on extra cost of building it below the pond level, and having sand and water to contend with. If our pond had been an artificial one, with a dam at one side, we would have placed the filter where the pond water would flow onto it.

The filter bed being above the pond level, we are able to drain out the water at any time. When the odor in the filtered water, in the collecting well in the center of the filter bed, was at its worst, we drew out all the water from the well and entered it. We found water still slowly running in through the underdrains from the filter bed. On collecting that water and testing it outside we found that it had neither color nor odor, showing conclusively that the filter bed was doing its work well, and that the odor noticed had been created after the water had left the filter bed and entered the well.

We could ascribe its cause to be the heat of the water, intensified by the mode of construction of the roof. Our engineer, Mr. Joseph B. Rider, had originally designed a flat, submerged roof for this well, and he has this year advised its construction as a probable means of overcoming the troublesome odor. Of course, it would also be an improvement to cover the whole filter, to keep it cooler. Pond water averages 76° F., and about 71° in the pipes in town. As soon as the temperature fell to 60° last fall we had no trouble of any kind with the filter. This year the water has been perfect, so far, and it is quite probable that it will remain so, as it did in 1892, which followed a year when water was bad in the fall. Perhaps there was no food left for the growth of anabaena, in any quantity. Last year we scraped the filter bed only once, and there did not seem to be any need of it again. The cost given, $4,800, includes, say, $300 for pipes, connecting the filter and pumping station, so that about $4,500 belongs to the filter proper, giving the cost per acre about $42,600. Our tank is so small (50,000 gallons capacity) that water does not remain in it long at this time of the year, when we use 200,000 gallons daily. If it were larger, there would be greater necessity of covering it to hold filtered water. Respectfully, W. F. Codd.

Superintendent Wannacomet Water Co.

Nantucket, Mass., Aug. 11, 1894.

OBSERVATIONS ON EVAPORATION FROM WATER SURFACES.

Sir: In your issue of April 12, 1894, there appeared a note regarding some experiments on evaporation made at Cornell University. Can you give a description of the instrument used for this purpose, and will you inform me whether similar observations have been made elsewhere, and whether instruments are manufactured for the measurement of evaporation? I am thinking of making some observations on evaporation in this section shortly. Respectfully.

H. B. Hedges.

San Bernardino, Cal., July 23, 1894.

(The evaporation experiments at Cornell were under the direction of Prof. E. A. Fuertes, M. Am. Soc. C. E., Director of the New York State Weather Service, who has kindly sent us some particulars regarding the instrument used, with comments on the general subject of evaporation observations, which we give below.

An elaborate investigation of this subject was made some years ago by Mr. Desmond Fitz Gerald, M. Am. Soc. C. E., and published in the Transactions of the American Society of Civil Engineers, vol. XV., pp. 581-647. An abstract of this paper was presented in Engineering News for April 10, 1886.—Ed.)

Sir: Regarding Mr. H. B. Hedges' inquiry for information as to evaporation observations, I have to say that I know of nothing better as yet than Fitz Gerald's experiments and what may be found in the U. S. Weather Review for 1888, p. 235, where an account is given of the Piche evaporimeter.

I have been urging for some time to the general government the introduction of evaporation gages as a most important element of meteorology in respect to agricultural and commercial, sanitary and scientific purposes. The daily evaporation from the surface of the United States has been generally assumed by engineers to be about 0.4 in. in 24 hours. But experiments prove that this may be doubled under certain conditions of dryness, temperature and pressure; and at other times the evaporation may be negative; that is, moisture is actually added to the contents of the evaporation gage. What the resultant effect of these changes is no one can at present foresee; for the question has not been properly studied before for utilitarian purposes.

The N. Y. Meteorological Bureau has an evaporation gage constructed by Richard Freres, of Paris. It is simply a weighing machine in which the moment of the weight of the water evaporated is controlled by a heavy counterpoise fixed to the center of motion of the scale. This machine has been modified by the addition of a dashpot to avoid the oscillations caused by the wind, which made the automatic record blurred and unintelligible. Mercury was first tried as the regulating medium, then glycerine and lastly kerosene oil, which latter seems to give the best results with all necessary sensitiveness and accuracy. The machine is provided with a system of levers which actuate a pen, making an automatic diagram upon a cylinder moved by clockwork.

It is strange indeed that since the absence of moisture is so deleterious to health and the growth of plants, so little has been done to determine its amount and effects by practical tests, since there seems to be no other possible way of studying this subject than by the multiplication of experiments at properly chosen places, to be discussed after a sufficient number of them have been obtained. One can form an idea of the importance of evaporation by a simple computation upon the Erie Canal. Allowing an evaporation of ¼ in. per day, the engineer must supply over 32,000 cu. ft. of water per hour to offset the evaporation for each hundred miles of canal. Similar figures upon the evaporation of reservoirs, lakes, etc., as used for irrigation or drinking or power purposes, will show the necessity of further study on this point, even throwing out of consideration the important elements of health and productiveness of the soil.

The study of evaporation is far more difficult than that of rainfall; and as with rainfall, the evaporation at different elevations above a given point varies widely. Also the condition of the ground, as to whether it has been recently ploughed or is planted with short or long grass, in the neighborhood of swamps or in high land. The same gage will give very different results within a few hundred feet of the same place. Therefore the most important point to consider is the establishment of standard conditions so that observations at various places may be comparable among themselves. This question is beset with considerable difficulties, and I would be much obliged for information or discussion upon this subject. I may say, however, that I have placed the gage we have in our bureau about 2 ft. above the ground in an open space where the grass is kept short. The pan carrying the vessel which contains the water is sunk in a box so that the entire machine is sheltered from the wind, the glass jar containing the water only protruding above the box, and so arranged that it can move up and down as the water evaporates or additional water is added, without touching the box. About the machine, a shelter has been built made up of broad louvres which, while they allow free air circulation, prevent the sun from striking the water during the entire day. Near the ground and about the shelter, a wire netting has been placed high enough to prevent the entrance of frogs, etc. Provision is made in this gage to so replenish the reservoir that the water may always be about the same height below the edge of the vessel containing it. The characteristics of the curve representing the normal evaporation seem to be a sudden convexity upwards, beginning at about 2 p. m., with a gradually increasing radius of curvature until about midnight. From this time until about 10 or 11 a. m. the evaporation hardly amounts to 1 mm. (.039 in.). This is again repeated in regular cycles in which, however, the actual evaporation is apt to vary considerably in amount from day to day. We have not sufficiently accurate information for the entire year; but there are reasons to believe that winter evaporation, is occasionally as brisk as in midsummer. I shall be glad at all times if Mr. Hedges desires further information or can give us any advice to further the interests of this question, to co-operate with him to the extent of our resources.

Very respectfully yours, E. A. Fuertes,

Director New York State Weather Service.

Ithaca, N. Y., Aug. 9, 1894.

A RATIONAL FORMULA FOR COLUMNS.

Sir: I think there is an error in equation (3) of Professor Merriman's article, on page 46 of your issue of July 19. The + sign should be —, making it read

$$I - \frac{P}{O} r^2 = \frac{n P l^2}{\pi^2 E},$$

The example also contains an error. As I figure it the equations to be corrected should read: $I - 24 r^2 = 14.75$, not 147.5, $x^4 - 24 x = 177$, from which $x^2 = 29.92$ ins., $x = 5.47$ ins. and the unit load $B = 802$ lbs.

To prove this, substitute the values found in eq. (1) and solve for C:

$$C = \frac{802}{1 - \frac{1}{10} \times \frac{802}{1{,}500{,}000} \times \frac{16^2 \times 12^2}{\frac{29.92}{12}}} = 1{,}000$$

the figure originally assumed.

Yours truly, Wm. Kent.

Passaic, N. J., July 20, 1894.

(Prof. Merriman informs us that the sign + should be —, as stated by Mr. Kent.—Ed.)

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BEAVER MEADOW, TRESCKOW & NEW BOSTON.—A. S. Van Wickle, Pres., Hazleton, Pa., writes us that the contract for constructing this railway has been awarded to H. R. King, Hazleton, and that the work will be pushed with all possible rapidity. The road will be 18 miles in length and will extend from Beaver Meadow to New Boston, Pa., where it will connect with the Pennsylvania system. The construction of the road was commenced last week.

KINGFIELD & DEAD RIVER.—This narrow gage railway in Maine is now open for passenger traffic. It extends from Kingfield to Carrabassett, 11 miles, and is virtually an extension of the Franklin & Megantic.

PENNSYLVANIA MIDLAND.—E. A. Tennis, Thompsontown, Pa., who is building this railway, is reported as stating that the main line will be completed early next month, and will be ready for operation by Nov. 1. This portion of the line is from Senesta Station on the Pennsylvania to Brook's Mills in Blair county, Pa., about 23 miles. Besides the main line a branch road has been located from Osterburgh crossing to the Allegheny Mountains with a maximum grade of 85 ft. to the mile into Somerset county, where the projectors of the railway own large coal fields. The branch will be 18 miles long and will not be completed until after January next.

PHILADELPHIA & READING.—It is stated that the main line of this road will be relaid with new 80-lb. steel rails. The work has already been begun. The old rails will be put down on branch lines.

Projects and Surveys.

CAPE COD SOUTH SIDE.—This road, noted last week, is projected from North Falmouth to Hyannis, Mass., about 20 miles, passing through East Falmouth, Waquoit, Mashpee, Cotuit, Osterville and Centerville. F. W. Parsons, Pres., Wianno, Mass.

ELWOOD NORTHERN.—Incorporated in Pennsylvania, Aug. 9, to build a railway from a point on Duck Run branch of the Pittsburg & Western near Slippery Run Creek to a point on said creek near Campbells; capital stock, $50,000; Pres., Merritt Greene, Edgeworth, Pa.

INDIANAPOLIS, BLOOMINGTON & BEDFORD.—Newell Sanders, Pres., Chattanooga, Tenn., is reported as planning to commence work soon on this road, which is projected from Indianapolis to Bedford, Ind., a distance of 80 miles.

SWIFT RIVER.—We are informed that this railway, noted last week, is desired to be completed within a year and that the construction will probably be commenced at an early date. Half of the location is made.

WADDINGTON, CANTON & SOUTHERN.—Incorporated in New York, Aug. 7, to construct a standard gage steam road about 28 miles long from Dry Island, in the St. Lawrence River near Waddington, to High Falls, on the Grasse River, in Canton, St. Lawrence county; capital stock, $500,000; directors, James Spears, John C. Keeler, Henry E. Seaver, Reuben T. Wells and Simeon D. Bridge, of Canton, N. Y.; John G. Tait and William W. Proctor, of Waddington, N. Y.; Frederick J. Merriman, of Madrid, N. Y.; and Joseph G. Taylor, of Buffalo, N. Y.

WASHINGTON COUNTY.—The directors of this company in Maine, chartered by the last legislature, have organized: Pres., Geo. A. Curran, Calais, Me.; Treas., N. B. Nutt, Eastport, Me.; Clk., Geo. A. Murchie, Calais, Me.

Southern—Existing Roads.

HARRIMAN COAL, IRON & RY.—It is stated that the Cumberland Construction Co. will soon complete the Brushy Mountain extension of this road. The line will be 12 miles long, and was partly graded in 1892. The construction was resumed on June 23. G. W. Chandler, Secy. and Treas., Cumberland Construction Co., Harriman, Tenn., is in charge of the work.

MONTGOMERY, HAYNEVILLE & CAMDEN.—S. D. Broch, Pres., Camden, Ala., is reported as stating that it is expected to complete and place in operation 30 miles of road this year. The road is projected from Camden to Montgomery, 73 miles, and 11 miles are graded.

POTOMAC, FREDERICKSBURG & PIEDMONT.—This narrow gage railway extends from Fredericksburg to Orange Court House, Va., 38 miles, connecting with the Chesapeake & Ohio at Orange for the transportation of freight. A press report states that a third rail will be put down to run the broad gage freight cars, and a spur will soon be constructed to run the passenger train of the narrow gage to a point near the Virginia Midland depot in Orange.

Projects and Surveys.

ROCKPORT, INDIANAPOLIS & CHATTANOOGA.—A press report from Owensboro, Ky., states that a large corps of engineers, with headquarters at Rockport, Ind., are at work on this proposed railway, which is projected from Rockport, Ind. (on the Ohio River) to Chattanooga, Tenn.

Northwest—Existing Roads.

BRAINERD & NORTHERN MINNESOTA.—A contract for building an additional 15 miles of this road has been awarded to Foley Bros. & Guthrie, St. Paul, who have nearly completed the contract awarded them in the spring, and it is expected that the line will be completed from Hubert Lake to near Leech Lake, Minn., together with 15 or 20 miles of branches, by October. Ch. Engr., F. W. Kimball, Brainerd, Minn.

CHICAGO & NORTHWESTERN.—It is stated that this company has definitely decided to construct a double track from Madison to Elroy, Wis., a distance of 75 miles. This will give the company practically a double line from Chicago to Elroy with the exception of the line from Madison to Evansville, which will be double-tracked when the other work is done. The work of tracklaying will not be begun till next season, but culverts and bridges are now being rebuilt with a view to laying the double track. The total cost of the work from Madison to Elroy is estimated at $1,736,937. Work will be under the supervision of C. C. Puder, Div. Engr., Madison, Wis., who is now preparing plans.

Projects and Surveys.

OMAHA, ST. PAUL & WHITE BEAR.—Incorporated at St. Paul, Minn., Aug. 8 to construct and operate a railway in Ramsey county; capital stock, $50,000; W. P. Warren, Troy, N. Y.; P. S. Macgowan, F. V. Bartlett, H. P. Finnigan, and R. F. Ball, of St. Paul.

Southwest—Existing Roads.

CHOCTAW COAL & RY.—Bids will be received by Sept. 1, according to reports, for the construction of this railway from South McAlester, Ind. T., to Oklahoma, Okla., 120 miles. Ch. Engr., J. F. Hinckley, South McAlester, Ind. T.

Projects and Surveys.

KANSAS CITY, OKLAHOMA & PACIFIC.—The House has passed a bill granting this company a right of way through Indian Territory.

LEXINGTON & SOUTH CANADIAN VALLEY.—Incorporated in Oklahoma, Aug. 10, with a capital stock of $1,000,000; directors, E. J. Keller, J. S. Lyttle, S. C. Hawke, B. Weitzenhoffer, F. W. Hawes, J. R. Vivian, E. N. Abernathy, W. S. Upp, J. M. Stovall, W. H. Johnson, H. L. Forehand, J. C. Dowdy, W. H. Blackwell, all of Lexington, Okla.

ST. LOUIS, AVOYELLES & SOUTHWESTERN.—It is stated that the construction of this railway will be commenced this week. The road will extend from Bunkie, La., to Marksville and Simmesport. Pres., F. M. Welch, Marksville (or Alexandria), La.

TEXAS.—Jos. Landa, New Braunfels, Tex., is reported as interested in a railway projected from New Braunfels, on the International & Great Northern, to Marion, on the Southern Pacific, and thence south to a point on the line of the San Antonio & Aransas Pass and the San Antonio & Gulf Shore.

Rocky Mt. & Pacific—Existing Roads.

SALT LAKE & MERCUR.—The incorporation of this company was noted Aug. 2. The contract for building the road has been awarded to Daniels & Holdaway, Provo City, Utah, who have a large force at work on the grading. Pres., A. A. Noon, Provo City, Utah.

UTAH CENTRAL.—The Salt Lake City "Tribune" states as follows: The Utah Central Ry. Co. will probably be the first to build an extension into this almost unexplored but rich domain. The idea is to eventually build in an easterly and southerly direction from Park City, crossing the Uintah reservation from 10 to 12 miles north of Daniel's Pass, thence easterly to a point in the vicinity of Wolf Creek Pass, and to the Duchesne River, from 20 to 30 miles east from the point of entrance, and from there eastward, over the best route that can be secured, to the Colorado state line, to connect with one of the numerous lines now projected westward. The extension will pass south of Fort Duchesne, and the company will have comparatively smooth sailing after crossing the Uintah mountains, as there is plenty of timber and a splendid grade almost the entire distance of 178 miles. From Park City east to Moon's mill, a distance of 25 miles, the grade is already completed.

Projects and Surveys.

WEISER & IDAHO NORTHERN.—Reincorporated in Idaho, Aug. 4, to build the railway projected from Weiser, Idaho, north about 50 miles towards the Seven Devils mining district; capital stock, $10,000,000; Pres., Leonidas Merritt; Vice-Pres., Thos. Baten; Secy., M. S. Sprote; Treas., I. J. Richardson; Asst. Treas., H. S. Ely. The incorporators are mostly Duluth capitalists.

Foreign.

MEXICAN.—A press report from Monterey, Mex., states that the general government has approved the plans for the proposed mineral road that is to be built from that city to the mining district of San Pedro. J. A. Robertson, Gen. Man. and Receiver, Monterey & Mexican Gulf, is at the head of this new enterprise. The work of constructing the line is expected to begin immediately.

OAHU RY. & LAND CO.—The Seattle, Wash., "Post-Intelligencer" states that A. Feek, of that city, has secured the contract for building a narrow gage railway around the island of Oahu, on which Honolulu is situated. The road will be built by the Oahu Ry. & Land Co., and will be 112½ miles in length, of which 18½ miles were built three years ago, and are now in operation. Mr. Feek stated Aug. 4 that the construction of the remainder of the road was commenced Aug. 1, and is to be completed in 2¼ years. The work will cost about $1,000,000. The grading will be easy. There will be two 200-ft. steel bridges, the remainder of the bridges being trestle-work. The ties will be of Puget Sound cedar and the bridge timber of Puget Sound fir. A contract for 3,000,000 ft. of cedar and fir timbers has been awarded to the Port Angeles Mill Co., and the contract for trestle-work, tracklaying, etc., has been awarded to J. N. Brickal, Seattle. English steel rails will be used.

STREET AND ELECTRIC RAILWAYS.

BANGOR, ME.—Gen. H. L. Mitchell is reported as making arrangements to construct an electric railway from this city to Frankfort.

BRIGHTON, MASS.—The Newtonville & Watertown Ry. Co. has petitioned the aldermen for a franchise to construct an electric railway through the city.

CONWAY, MASS.—Bids are asked until Aug. 18 for constructing a power house and furnishing engine, boiler and electrical apparatus for the Conway Electric St. Ry.—Bids for constructing five miles of track were called for until Aug. 16. A. P. Delabarre, Chn. Com.

GLOUCESTER, MASS.—The Gloucester & Rockport St. Ry. Co. has been incorporated with a capital stock of $40,000, to construct a street railway two miles long; directors, D. S. Fresson, D. A. White, Gloucester; W. B. Ferguson, Malden; A. D. Bosson, Chelsea.

ROCKLAND, MASS.—It is reported that there is talk of building an electric railway from Hingham through South Hingham, Queen Anne's Corner and Horwell to North Hanover to connect with the proposed road to this city.

CENTRAL FALLS, R. I.—The Moshassuck Valley Ry. Co. has petitioned the council for a franchise for an electric railway extension 4½ miles in length.

BERLIN, CONN.—The Central Ry. & Electric Co. has been granted a franchise for an electric railway between this city and New Britain. Treas., F. G. Platt.

FAIRFIELD, CONN.—The Traction Co. has petitioned for a franchise for an electric railway through this town and Southport. A committee consisting of Frederick Bronson, A. E. Rowland, Samuel Morehouse and others has been appointed to consider the project.

MANCHESTER, CONN.—The South Manchester Tramway Co. is reported as making surveys for an electric railway.—The Hartford, Manchester & Rockville Tramway Co. has opened bids for constructing an electric line from Manchester to Burnside.

MILFORD, CONN.—J. D. Brown is to petition the legislature for a franchise to build an electric railway from Woodmont through Stratford to this place, according to reports.

MORRIS, N. Y.—Surveys are being made for an electric railway between this place and Sidney, estimated to cost $100,000.

NEW YORK, N. Y.—The Metropolitan St. Ry. Co. has completed plans for a seven-story brick power house in East 25th St. for the Lexington Ave. cable line, estimated to cost $600,000.

PORT JERVIS, N. Y.—The Port Jervis & Suburban Co, the Port Jervis & Neversink Ry. Co. and a company from Salamanca have petitioned for franchises in this place.

POUGHKEEPSIE, N. Y.—Press reports state that the trolley road between this city and Wappinger's Falls, which is approaching completion, is one link in a chain of trolley systems connecting all the inland towns between New York and Albany. A road connecting Wappinger's Falls with Fishkill will next be constructed. Mr. Hinckley, the president of this company, is said to be one of the capitalists who are constructing this system.

SYRACUSE, N. Y.—The construction of four miles of double track electric railway has been commenced by Belden & Seeley, railway contractors. This road will be known as the Solvay branch of the Syracuse St. Ry., having its eastern terminus in Syracuse at the swing bridge and its western terminus in Solvay village near the works of the Solvay Process Co. Mather & Allen, 424-425 Kirk Bldg., Syracuse, are the engineers for the Syracuse St. Ry. Co.

YONKERS, N. Y.—The Yonkers Electric Ry. has been sold to the North & South Electric Ry. Co. Many extensions will be made. Supt., J. J. Coleman.

HACKENSACK, N. J.—Surveys are reported being made for an electric railway in Bergen county from Little Ferry to Cherry Hill, a distance of four miles, for the Bergen Turnpike Co. Pres., Andrew Zabriskie.

HARRISON, N. J.—The council has granted a franchise to the Jersey City, Harrison & Kearney Traction Co., and the Consolidated Traction Co., for an electric line on Harrison Ave.

MILLVILLE, N. J.—The Millville Traction Co. has been incorporated with a capital stock of $400,000; Pres., G. B. Langley, Millville; directors, Geo. Wood, 626 Chestnut St., Philadelphia; W. B. Monroe, Millville; J. K. Russell, Vineland.

BERWICK, PA.—A company is being formed to construct an electric railway between this place, Nanticoke and Hazleton. The projectors intend to bond the road for $1,500,000, and build about 23 miles of road, according to reports.

DOYLESTOWN, PA.—The Bucks County Ry. Co. has been incorporated to build an electric railway from this city to Centreville and Newtown; capital stock, $100,000; incorporators, Francis Fenimore, St. David's; W. J. Fell, R. C. Fulton and M. S. Lynch, Philadelphia.

HUMMELSTOWN, PA.—It is reported that the electric railway at Harrisburg will be extended to this place.

LANCASTER, PA.—The Lancaster Ry. Construction Co. has been incorporated with a capital stock of $100,000, by Henry Baumgardner, G. N. Reynolds, F. H. Steacy, Lancaster; H. E. Crilly, Allentown; Theodore Mace, Trenton, N. J.

PHILADELPHIA, PA.—The Aramingo Ave. Passenger Ry. Co. has been incorporated with a capital stock of $12,000; Pres., H. C. Moore, 624 North 22d St.

READING, PA.—B. F. Owen, Pres., Reading & Temple Electric Ry. Co., writes us that the company has received a franchise for a line 4½ miles long within the city limits, three miles of which will be built this fall, and 3½ miles outside the limits to Temple, to be constructed as soon as right of way is secured. The road to Temple will be a straight line, with light grade, and will be laid with T-rails. The line in the city will have 90-lb. girder rails, ties 2½ ft. apart. Brill cars, 16 ft., with power sufficient to drag open trailers. The contracts are made and construction commenced.

ANNAPOLIS, MD.—The Annapolis & Bay Ridge Traction Co. is reported about to be incorporated to construct an electric railway.

BALTIMORE, MD.—Surveys are being made for an extension of the electric line of the City & Suburban Ry. from Catonsville to Ellicott City. Surveys have been completed for an electric line from Point Breeze to Sparrows Point. F. H. Sloan, Ch. Engr.

ST. AUGUSTINE, FLA.—The St. Augustine Electric Ry. Co. has completed arrangements for the building of its line, and the construction will be commenced within 90 days, according to reports. Pres., E. M. Homes; Secy. and Treas., Chas. Sperry; Gen. Man., T. W. Jackson.

COLUMBUS, O.—The Columbus & Buckeye Lake St. Ry. Co. has been incorporated to build an electric railway along the National Road to Buckeye Lake.

ANDERSON, IND.—A franchise has been granted to N. J. Clodfelter, Crawfordsville; V. C. Quick and A. N. Painter, Alexandria; to construct the Indiana Gas Belt Electric Line through Madison county. The proposed railway would connect at Marion with Indianapolis, passing through Pendleton, Anderson and Alexandria, a distance of 75 miles. Capital stock, $200,000.

LUDINGTON, MICH.—The Citizens' Development Co. has petitioned for a franchise for an electric street railway.

PEKIN, ILL.—The Pekin & Peoria Ry. Co. has petitioned for a 20-year franchise for an electric railway. Pres., W. J. Conzelman.

IOWA CITY, IA.—It is reported that a street railway will soon be constructed at this place.

ATCHISON, KAN.—It is reported that a company has been formed and will apply for a franchise.

ST. LOUIS, MO.—It is reported that the Citizens' Ry. Co. intends to change the Franklin Ave. cable line to an electric line.

LOS ANGELES, CAL.—The Los Angeles Consolidated Electric Ry. Co. has petitioned for a franchise for extending its line.

MERCED, CAL.—Press reports state that G. A. Wulkup, Chicago, builder and one of the owners of the Hutchinson & Southern R. R., has completed arrangements to build an electric road from this city to Yosemite, a distance of 70 miles. Mr. Wulkup represents a company of Eastern capitalists that has over $3,000,000 invested here. Power will also be furnished to the various manufacturing interests in Merced, which will be generated from Merced Falls.

SAN JOSE, CAL.—J. M. Powell has petitioned the supervisors for a franchise for an electric railway from this city to Gilroy, a distance of 30 miles.—— B. H. Quincey has petitioned for a franchise for an electric railway at Alum Rock Park.

GUELPH, ONT.—George Sleeman has been granted a 30-year franchise for an electric railway. Two miles are to be built next year and one mile each of the next four years.

NIAGARA FALLS, ONT.—The Clifton & Drummondsville R. R., between Niagara Falls and Niagara Falls South, has been sold and will be changed to an electric railway, according to reports. J. A. Lowell and W. M. German, of Welland county, are at the head of the new company.

HIGHWAYS.

MASSACHUSETTS.—Bids are asked by the Boston water board until Aug. 23 for building two roads at basin No. 2 in Southborough, consisting of the following work: Earth excavation, 212,000 cu. yds.; split stone masonry, in mortar, 650 cu. yds.; paving in mortar, 122 cu. yds.; concrete, 100 cu. yds.; dry paving, 1,900 sq. yds.; riprap, 1,670 cu. yds.; stone wall, 120 rods.——The Essex county commissioners have received an appropriation of $25,000, which will be used in constructing a highway from Salem through Wenham to Ipswich.

NEW YORK.—H. P. Morrison, Engr., Richmond county, Stapleton, S. I., writes us that contracts for constructing the highways, recently advertised, have been awarded as follows: Donovan Bros., Port Richmond, roads 1, 2, 3, 4, 5 and 7; John McQuade, West New Brighton, No. 6. The itemized bids will be published in a later issue.

PENNSYLVANIA.—It is reported that right of way has been granted for a boulevard from Munhall to Duquesne, a distance of 4½ miles.

KENTUCKY.—It is proposed to construct a highway from Mount Sterling to Clay City, Powell county; estimated cost, $1,200 a mile.

WISCONSIN.—A plan to extend the Sheridan Drive from Chicago to Milwaukee has been proposed by the Merchants' Association of Milwaukee. The following persons are among those interested: C. C. Rogers, F. W. Rogers, Samuel McCord, T. W. Spence, T. L. Kelley, Patrick Cudihy and others, of Milwaukee. A meeting will be held Aug. 20 to organize a company.

WYOMING.—The board of trade of Buffalo is taking active steps towards the construction of a road into the Big Horn Basin. C. H. Bemite, Mayor, Buffalo, is interested.

TEXAS.—It is reported that arrangements are being made to macadamize a portion of the road between Denton and the Elm River, which will be mainly done by private subscription.

IDAHO.—A report from Boise City, Idaho, states that the state wagon road commission has advertised for bids for constructing the Wallace division of the state road, and that the contract for building the St. Mary's division has been awarded to Cameron & Lytch.

BRIDGES AND TUNNELS.

HARTFORD, CONN.—Two more spans of the old bridge across the Connecticut River to East Hartford are reported in danger of falling, and the state bridge commission has asked legal opinion as to its right to build a new bridge.

CUMBERLAND, MD.—The contract for a bridge over the Potomac at Luke, Md., has been awarded to the Youngstown Bridge Co., at $7,301; time, 3 months.

WASHINGTON, D. C.—The superintendent of bridges has recommended the following work: Reconstruction of K St. bridge over Rock Creek, estimated to cost $20,000; also of Navy Yard bridge over the Eastern Branch, $250,000, and M St. bridge over Rock Creek, $30,000, and that the approaches and superstructure of P St. bridge over Rock Creek be widened, $35,000, and that a bridge be constructed over Rock Creek on the line of Massachusetts Ave., at a cost of $175,000.

SAVANNAH, GA.—The following bids were received for constructing the Skidaway bridge: Walter A. Dayton, $4,760 to $4,985; Martin Cooley, $3,170; H. N. Pregnall, Charleston, $4,800; E. F. Cordray, $4,500.

DAYTON, O.—The city comptroller has been authorized to advertise for bids for an iron hoist bridge over the canal at Warren St.

TOLEDO, O.—Bids are asked until Sept. 10 for the erection of an iron or steel bridge over Swan Creek on St. Clair St., bidder to furnish plans. L. P. Harris, Cy. Clk.

TROY, O.—Bids are asked until Aug. 25 for the erection of a high truss iron bridge over the Great Miami River, near Piqua. B. E. Furnas, Co. Audr.

BRAZIL, IND.—Two bridges on the Chicago & Eastern Illinois R. R., near this city, were burned Aug. 7.

INDIANAPOLIS, IND.—The county commissioners have decided to receive bids for a bridge across Pleasant Run at Washington St., and another across White River at First St. The latter bridge will cost about $25,000. It will connect First St. with the Osterman free gravel road in Wayne township.

BUCHANAN, MICH.—The citizens have voted, 296 to 29, to issue bonds for a new bridge over the St. Joseph River.

MINNEAPOLIS, MINN.—F. W. Cappelen, Cy. Engr., has reported that to widen the stone arch bridge on Central Ave. over the east channel would cost $24,800 for the steel construction and $6,350 for the masonry, etc.—The bridge over the Great Northern tracks at Como Ave. was burned Aug. 6, and it is thought probable that a new iron structure, costing about $50,000, will now be erected. Such a bridge has been proposed for several years.

HELENA, MONT.—Bids are asked until Sept. 10 for the construction of two 65-ft. iron or steel bridges across Ten Mile Creek, including superstructure, substructure and the necessary grading. J. S. Tooker, County Clk.

ATCHISON, KAN.—The Atchison Bridge Co. is reported as about to strengthen the bank of the river at East Atchison, the stonework necessary being estimated to cost $150,000.

NEW WHATCOM, WASH.—The county commissioners have decided to ask for bids for the construction of two more bridges across the Nooksack River, one at Welcome, above the Middle Fork, and one at Acme, on the South Fork. The Welcome bridge will be about 175 ft. long and the one at Acme about 160 ft. Contractors will furnish plans and specifications.

WATER-WORKS.

PITTSFIELD, ME.—The committee has contracted with C. F. Parks, Boston, to put in works.

THOMASTON, ME.—The citizens are talking of municipal works. The present supply is furnished by the Rockland Water Co., which furnishes also Rockland, Rockport and Camden.

HUDSON, MASS.—At a meeting Aug. 8 the citizens voted to indefinitely postpone the question of another main and other improvements.

LOWELL, MASS.—The contract for the proposed tube well plant has been awarded to the Hydraulic Construction Co., New York, at $19,749 for a year's pumpage, the contractor to provide the plant and furnish a daily supply of at least 2,000,000 gallons without robbing the tube wells already sunk.

LYNN, MASS.—Several plans are being considered for better service for the highlands; estimated cost, $36,500 to $51,600.

SCITUATE, MASS.—The Scituate Water Co. is having surveys made for works.

ALBANY, N. Y.—The contract for 11,200 ft. of 30-in. pipe which is to be laid from the pumping station at Quackenbush St. to the Prospect Hill reservoir, has been awarded to the Camden Iron Wks., at $34,076. The Chattanooga Foundry & Pipe Wks. bid $35,628, and F. B. Hawkins, New York, $36,500. Bids are being received this week, according to reports, for laying the pipe.

DUNKIRK, N. Y.—The contract for the new pump has been awarded to the Snow Steam Pump Co., at $13,000, less $1,000 for the old pump.

FORESTVILLE, N. Y.—A sufficient supply has been secured about a mile from the village, where a small reservoir will be built, and works will probably be put in soon.

HAMILTON, N. Y.—The citizens have voted, 272 to 41, in favor of works.

LE ROY, N. Y.—The trustees are considering the granting of a franchise. It is thought that the village would pay $40 a year each for 50 hydrants.

MANLIUS, N. Y.—The board received 20 bids for constructing works, the lowest being that of Beckwith & Quackenbush, Herkimer, at $15,722.

MONTICELLO, N. Y.—The citizens have voted in favor of works.

NEW YORK, N. Y.—Bids are asked by the commissioners of quarantine until Aug. 24 for laying a pipe line to Hoffman and Swinburne islands, as stated in our advertising columns.

RICHMONDVILLE, N. Y.—Bids are asked by the commissioners until Aug. 29 for constructing works, as stated in our advertising columns.

SARANAC LAKE, N. Y.—The contract for works is reported to have been awarded to W. H. Lang, Burlington, Vt.

SYRACUSE, N. Y.—The lowest bid for trenching and pipelaying was that of Fales & O'Donnell, North Tonawanda, at $13,176. The itemized bids will be published in a later issue. Ch. Engr., W. R. Hill.

ASBURY PARK, N. J.—The West Side Water Co. has been incorporated with a capital stock of $25,000 by Washington White, A. M. White, B. Crowell and others, all of West Asbury Park.

BELLEVILLE, N. J.—Bids are asked by the committee for extensions, according to reports.

PATERSON, N. J.—The contract for drilling two wells has been awarded to Ricker Bros., at $1.85 per ft. W. J. Carman & Co. bid $1.95, C. P. Cramer $2, and H. E. Hopper $2.45.

BLOOMSBURG, PA.—The stockholders of the Bloomsburg Water Co. have voted to increase the capital stock from $90,000 to $180,000.

CARNEGIE, PA.—The question of works and electric lights is being discussed.

ELMHURST, PA.—It is stated that within a few weeks works will be put in by a private company.

KITTANNING, PA.—Bids are asked until Aug. 25 for building a reservoir for the Armstrong Water Co., as stated in our advertising columns.

LANCASTER, PA.—Bids are asked until Aug. 25 for constructing the plant of the Christiana Gravity Water Co., noted last week as incorporated. The work will include 1,900 ft. of 6 and 4-in. terra cotta pipe, 50,000-gallon reservoir, 10,500 ft. of 8-in. cast iron pipe and a distribution system of 8 to 4-in. pipe. Engr., A. A. Herr, 108 East King St. Address W. F. Beyer, Solicitor, 43 East Grant St.

LEBANON, PA.—Wm. H. McCullough has submitted plans for an increased supply.

MARION, PA.—There is talk of works.

RANKIN, PA.—The contract for works has been awarded to John P. McEntire, McKeesport, at $16,805.

RIDGWAY, PA.—The works will probably be extended to suburbs of the city, a better supply secured from mountain streams and a new reservoir built. F. H. Ely, Secy.

TROUT RUN, PA.—The Trout Run Water Co. has been organized; Pres., John Wister; Secy., W. L. Coover; Treas., P. F. Duncan.

WILLIAMSPORT, PA.—The Summit Water Co. is reported about to sink more artesian wells and build a reservoir.

ANNAPOLIS, MD.—Bids are asked by the Annapolis Water Co. for furnishing 130,000 hard-burned brick and 250 bbls. of cement; also for laying same in reservoir. Engrs., Jas. H. Harlow & Co., Pittsburg, Pa.

ELLICOTT CITY, MD.—The engineer has reported that works will cost $28,000 and the council has decided to abandon the proposed improvement. The last legislature authorized the city to issue $30,000 in bonds for works.

ALEXANDRIA, VA.—The Suburban Water Co. has been incorporated to construct works in Fairfax and Alexandria counties; capital stock, $5,000; Pres., Geo. R. Hill; Vice-Pres., Wm. B. Smoot; Secy. and Treas., J. M. Hill.

ASHLAND, VA.—The council is reported as investigating the question of proposed works.

ASHLAND, VA.—The council is considering plans for works and electric lights.

WINSTON, N. C.—J. O. Magruder, Cy. Engr., writes us that the citizens voted Aug. 7 to issue $100,000 in bonds to extend and improve the works.

BARTOW, FLA.—The contract for works has been awarded to the Howe Pump & Engine Co., Indianapolis, and that for the wells to the Bartow Tube Well Co.; total cost, about $13,500.

DECATUR, ALA.—The Decatur Water-Works Co. was incorporated in West Virginia Aug. 8; capital stock, $50,000; Jas. T. Pertle and A. F. Callahan, Louisville, Ky.; L. B. Gleason, New York; E. G. McInnis and M. H. Hoffman, Boston.

ALEXANDRIA, LA.—An election will be held Sept. 8 to vote on a tax for works and electric lights.

ASHLAND, O.—C. G. Ducomb, Cy. Clk., writes us that the citizens have voted, 751 to 89, in favor of issuing $45,000 in bonds for works. The council proceeded at once to pass the ordinances to construct and to issue bonds.

BELLVIEW, O.—A contract for two 1,000,000-gallon pumping engines has been awarded to the Laidlaw-Dunn-Gordon Co.

CAREY, O.—The contract for the proposed works has been awarded to Snyder & Frederick, Carey, at $24,900 for the complete plant; Ludlow hydrants, Rensselaer valves and Laidlaw-Dunn-Gordon pumps are to be used. Engr., J. S. Humphrey, Findlay, O.

CINCINNATI, O.—The board of administration is considering a site for a reservoir to cover 10 acres in Burnet Woods Park.

LAKESIDE, O.—Plans are being considered for works to cost $10,000. Frank Briggs, Delta; Rev. L. A. Belt, Kenton, and C. A. Fleck, Tiffin, were appointed a committee to secure the necessary money.

NEW MATAMORAS, O.—E. J. Millar, Engr., Martins Ferry, O., is preparing plans for works.

SPRINGFIELD, O.—Bids are asked until Aug. 23 (postponement from Aug. 14) for constructing wells, 36-in. influent pipe, brick boiler and engine house, etc., as stated in our advertising columns of last week. Consult. Engr., J. D. Cook, Toledo. E. C. Gwyn, Clk.

ST. BERNARD, O.—Geo. Hornung, Consult. Engr., Cincinnati, informs us that the following bids were received last month.

For Power Machinery and Steam Plant.

J. & E. Greenwald Co., Cincinnati (aw'd contract)	$7,200
Lane & Bodley Co., Cincinnati	6,725
Houston, Stanwood & Gamble, Cincin'ti (informal)	7,160

For Water Tower.

R. Munroe & Son, Pittsburg, Pa.	$7,294
Mansfield Machine Wks., Mansfield, O.	6,571
Stacey Mfg. Co., Cincinnati	7,300
L. Schweiber & Sons Co., Cincin'ti (aw'd contract)	6,189
Cincinnati Architectural Iron Wks.	6,800
The Brownwell Co., Dayton, O.	6,546
Armstrong Bros., Springfield, O. (informal)	5,700
Enterprise Boiler Co., Youngstown, O.	7,940
Riter & Conley, Pittsburg, Pa. (informal)	7,500

DECATUR, IND.—It is reported that the contract for works has been awarded at $45,000.

WINCHESTER, IND.—The citizens have voted in favor of works.

CHESANING, MICH.—The citizens have voted in favor of works and electric lights.

DETROIT, MICH.—Bids are asked until Sept. 15 for the purchase of $100,000 of 30-year 4% water bonds. L. N. Chase, Supt.

QUINCY, MICH.—The proposition to issue $18,000 in bonds for works was carried Aug. 6 by 85 majority.

THREE RIVERS, MICH.—The city has contracted with the Barr Pumping Engine Co., Philadelphia, for additional pumping machinery to cost $2,585.

UNION CITY, MICH.—The council has been petitioned to investigate the advisability of putting in works.

AURORA, ILL.—The city has sold the $30,000 of 5% water bonds recently noted for $32,859.

CHICAGO, ILL.—Bids are asked, according to local papers, for borings and soundings for the proposed new tunnels. The total work contemplated is estimated to cost about $5,000,000. Cy. Engr., S. G. Artingstall.

COLFAX, ILL.—Recent fires in neighboring villages have caused the agitation of works.

DEKALB, ILL.—Bids are asked until Sept. 4 for pumping plant, boilers, reservoir, pipe and pipelaying, as stated in our advertising columns. Consult. Engr., Daniel W. Mead, Rockford, Ill. E. A. Porter, Cy. Clk.

FORRESTON, ILL.—Bids were asked until Aug. 24 for the construction of works. H. Dejough, Town Clk., writes us that the contract for sinking a well has been awarded to Gray Bros., Chicago.

MARSHALL, ILL.—Since the citizens voted against issuing bonds for works, a few weeks ago, several fires have occurred and the council has authorized another election to vote on the question.

QUINCY, ILL.—The committee has decided to ask the water company to lay nearly 5½ miles of new mains.

VANDALIA, ILL.—The question of issuing bonds for works was noted upon Aug. 14.

DODGEVILLE, WIS.—The contract for works has been awarded to Fairbanks, Morse & Co., Chicago, at $11,948.

GRANTSBURG, WIS.—An election will be held Aug. 21 to vote on the question of issuing bonds for works. us that the city has not been able to get a bid accom-

KAUKAUNA, WIS.—H. B. Tanner, Mayor, writes panied by a bond for a franchise.

LA CROSSE, WIS.—The city engineer has reported on the question of a supply, and it is reported probable that an expert engineer will be engaged.

STURGEON BAY, WIS.—The Sturgeon Bay Water Works & Electric Light Co. has been incorporated with a capital stock of $35,000.

ST. LOUIS, MO.—The lowest bids received Aug. 7 were reported as follows:

Howard-Harrison Iron Co., 7,140 tons pipe	$142,372
Shickel, Harrison & Howard Iron Co., 200 tons specials	8,694
St. Louis Iron & Mach. Wks., 261 stop valves.	11,332
" " " " 275 fire plugs..	59,082
R. J. McDonald, pipelaying	42,485

ALTON, IA.—Bids are asked until Aug. 28 for the construction of works. Consult. Engr., A. A. Richardson, Lincoln, Neb. Address the city clerk.

COLUMBUS JUNCTION, IA.—A company is reported as negotiating for a franchise for works estimated to cost $1,000.

COGGON, IA.—J. W. Funk, Cy. Recdr., writes us that the contract for constructing works has been awarded to Fairbanks, Morse & Co., Chicago, at $5,495. The work will include 3,320 ft. of 6 and 4-in. pipe, 8 hydrants, a steel trestle 40 ft. high, 33,000-gallon pumping engine, wooden tank, gasoline engine and deep well. The other bidders were the Challenge Pump Co., Batavia, Ill., $5,746; U. S. Wind Engine & Pump Co., Batavia, Ill., $5,750, and Geo. W. Wynn, Cedar Rapids, Ia., $5,795. The plans for the works were made by Geo. W. Wynn, Engr., Cedar Rapids.

FARMINGTON, IA.—The citizens have voted to issue bonds for works.

FORT DODGE, IA.—Bids are asked until Aug. 22 for constructing works, as stated in our advertising columns. Consult. Engr., Chas. F. Loweth, St. Paul. C. L. Granger, Chn. Com.

MASON CITY, IA.—The council has purchased a Pohle air lift pump for $2,100.

MONTEZUMA, IA.—Efforts are being made to secure works.

SIGOURNEY, IA.—The council has voted to secure estimates for works, estimated to cost $25,000 to $30,000. L. W. Richardson, Cy. Recdr.

WALKER, IA.—The following bids were received for constructing works, including 33,000-gallon wooden tank on trestle 65 ft. high, steam deep well pump, 1,625 ft. of 6-in. pipe, 160 ft. of 4-in. pipe, 7 hydrants and 4 valves; Engr., Geo. W. Wynn, Cedar Rapids, Ia.:

U. S. Wind Engine & Pump Co., Batavia, Ill.	$3,255
Challenge Wind Mill Co., Batavia, Ill.	3,319
Fairbanks, Morse & Co., Chicago	3,400

ALDEN, MINN.—Bids were opened Aug. 10 for $5,000 of bonds, but the plans for works have not yet been completed. Peter Hansen, Cy. Recdr.

N. MINN.—The citizens have voted to issue $5,000 in bonds for works.

FULDA, MINN.—Pike & Cook, Minneapolis, have prepared plans for works to cost about $10,000.

MINNEAPOLIS, MINN.—The city engineer has recommended the filtration of the supply from the Mississippi River, the proposed work being estimated as follows: Reservoir, $327,000; reservoir pipe lines, $60,000; main pipe lines, $260,000; drain pipe lines, $40,000; submerged pipe, $49,000; filter plant, $260,000; new pumps and boilers, $100,000; total, $1,096,000.——The city clerk has been authorized to advertise for bids for a submerged main across the river from 32d Ave. north to 25th Ave. northeast.

SPRING VALLEY, MINN.—J. C. Holbkat, Village Recdr., writes us that the contract for works has been awarded to John Torrance & Sons, Spring Valley, at $1,898.

ZUMBROTA, MINN.—It is reported probable that an election will soon be held to vote on an issue of bonds for extending the mains and building a tower and tank.

FULLERTON, NEB.—The contract for works has been awarded to the U. S. Wind Engine & Pump Co., as stated under our Contract Prices. Engr., G. H. Ellsworth.

HARVARD, NEB.—The lowest bid for constructing proposed works was $12,000, but the city can issue only $10,500 of bonds and a cheaper plant will be necessary or no works can be put in this year.

WYMORE, NEB.—At an election Aug. 7 the citizens voted to issue $10,000 in bonds for improving the works.

FLANDREAU, S. DAK.—The contract for works to cost about $15,000 has been awarded to E. H. Dow & Co., Sioux Falls, S. Dak.

ENID, OKLA.—E. W. Hill & Co. has been awarded a franchise for works and an electric light plant, to cost about $60,000.

NORMAN, OKLA.—A contract for two 500,000-gallon pumping engines has been awarded to the Laidlaw-Dunn-Gordon Co., Cincinnati.

VICTOR, COLO.—C. E. Stubbs and others, of Colorado Springs, have petitioned for a franchise to put in a $60,000 plant.

PORTLAND, ORE.—The city has sold $500,000 of additional water bonds, recently noted.

LAMANDA PARK, CAL.—The Lamanda Park Water Co. was incorporated Aug. 3.

SANTA BARBARA, CAL.—A. Hayman has been granted a 25-year franchise to lay mains in four streets.

ALEXANDRIA, ONT.—At an election, Aug. 14, the citizens voted to construct works by a vote of 3 to 1, and the works will be constructed this year. Potter & Folwell, New York, have prepared plans.

RANSOM, ONT.—The citizens have voted to issue bonds for works.

MONTREAL, QUE.—Bids are asked until Aug. 21 for a supply of water meters. A. Davis, Supt. W. W.

ARTESIAN WELLS.

ALPENA, S. DAK.—Land owners in Harmony township, Jerauld, county, have decided to sink two artesian wells as an experiment. D. McDonald, County Comr., is reported as in favor of expending about $50,000 for artesian wells.

IRRIGATION.

OREGON.—The Oregon Land, Irrigation, Fuel & Lumber Co., capital stock $500,000, is building 36 miles of canals for the irrigation of the Oak Grove, Juniper Flat and Wapanita Plains in Wasco county. About 20 miles of ditches have been completed and 50 teams and 125 men are now at work. It is stated that the force will soon be increased.

NEW COMPANIES.—Sherman County Irrigation, Water Power & Improvement Co., Loup City, Neb.; to operate in the counties of Valley and Sherman; $100,000; J. G. Schaupp, Theo. L. Pilger, C. L. Drake, Geo. H. Miller, Chas. Riedel, J. F. Hale and others. ——Paxton & Hershey Irrigating Canal Co., North Platte, Colo.; $100,000; W. A. Paxton, Jr., J. H. Hershey, F. T. Ransom, A. S. Briggs.——South Side Irrigation & Improvement Co., Dawson county, Neb.; $150,000; H. M. Knoll, W. E. Young, C. C. Campbell, J. D. Anderson, E. M. Young, G. W. Doll and J. N. France.——Great Western Land & Irrigation Co., Chicago, Ill.; $50,000.——Maxwell Irrigation Co., Pendleton, Ore.; $5,000.——Dry Gulch Ditch & Irrigation Co., New Bridge, Ore.; $2,000.

GRANT, NEB.—The citizens of this (Perkins) county will vote Aug. 16 on a proposition to issue $90,000 in bonds for an irrigation canal which is proposed from the South Platte River in Colorado, a distance of 60 miles.

NORTH PLATTE, NEB.—The Farmers & Merchants' Irrigation Co. has completed the first mile of its ditch, and is now considering contracts for the completion of the work. The company proposes to irrigate about 30,000 acres of land that is now yielding very small crops. The farmers have become aroused to the necessity of irrigation by the killing drouth and are making arrangements to form several companies for the construction of ditches. If the work now contemplated is carried out it is reported that there will be at least 100,000 acres of crop-producing land in this vicinity.

O'NEILL, NEB.—It is reported that Jas. M. Kerr, representing New York capitalists, was in the city Aug. 3 investigating the proposed ditch of the Niobrara River Irrigation Co. The ditch as projected will be 250 miles in length.

SEWERS.

MEDFORD, MASS.—The following bids were received Aug. 9 for pipe sewers:

	Sections 9 and 11.	Section 12.
A. W. Bryne, West Medford	$16,515	$9,173
J. J. Dorey, Somerville	17,980	....
Weaving-Booth Co., Medford	18,162	8,934
P. F. Lonergan & Co., Boston	18,401	9,063
National Construction Co., Boston	18,661	9,617
F. A. Snow, Boston	18,739	10,020
D. O'Connell, Boston	18,814	9,642
Falvey & Buttime, Somerville	18,901	8,561
Gennaro, Long & Little, S. Braintree	19,945	10,863
Crimmins & Collins, Somerville	21,952	11,652
Lindsey & Cudmore, Somerville	22,771	8,849
J. N. Drew & Co., Malden	22,936	10,215

The prices will be published in a later issue. The contract for manhole covers and frames has been awarded to the Union Iron Works, Lynn, at $4.52 each. Engr., T. Howard Barnes.

NEW HAVEN, CONN.—The aldermen are discussing the construction of a sewer in Prospect St.; estimated cost, $10,000.

BUFFALO, N. Y.—The council has received the following bids for constructing a 45 to 27-in. brick and 12-in. pipe sewer in Dingens St.:

John Mumm	$14,300
Christopher Smith	14,385
W. G. Smith	14,787
Aug. Gael	14,919
Henry Harter	15,100
J. C. Green	15,345
Jacob Ritzmann	15,573
Geo. Dark & T. Dark, Jr.	15,900
Thomas B. Reading	16,400
Elmer Mighton	16,430
William Franklin	17,656
Fred J. Martin	18,669

NIAGARA FALLS, N. Y.—Bids are asked until Aug. 24 for constructing a main trunk sewer, including three sections and 3,483 ft. of 7 × 9-ft. tunnel, as stated in our advertising columns. Cy. Engr., Albert H. Porter; Cy. Clk., L. P. Dayton.

NORTH TARRYTOWN, N. Y.—An election will be held Aug. 21 to vote on the question of appropriating $28,000 for sewers.

ROCHESTER, N. Y.—At a recent opening of bids for constructing sewers, nine bids were received for a sewer estimated to cost $150 and the contract was awarded at $96, and 13 bids for a sewer estimated to cost $975, the contract for the latter being awarded at $553.

SYRACUSE, N. Y.—It is proposed to construct a 36 and 24-in. brick sewer in Burnet St., estimated to cost $17,454. H. C. Allen, Cy. Engr.

BLOOMFIELD, N. J.—An ordinance has been introduced for a system estimated to cost about $74,000.

EAST ORANGE, N. J.—Arrangements are about completed for connecting the system of this place with that of Newark, the city to pay Newark $41,500 for this privilege. J. F. Fort, Township Counsel.

JERSEY CITY, N. J.—Bids are asked until Aug. 20 for constructing 3,615 ft. of 48 to 30-in. brick and 500 ft. of 48-in. iron pipe sewers. The work will include 1,800 lin. ft. of piles, 50,000 ft. B. M. of spruce sheathing, etc. Geo. T. Bouton, Clk. Bd. of St. and Water Comrs.

PATERSON, N. J.—It is proposed to construct about 1,300 ft. of 18 and 12-in. pipe and 1,200 ft. of 30 and 24-in. brick sewers. Thomas McLean, St. Comr.

BROWNSVILLE, PA.—Bids are asked until Aug. 21 for constructing 4,900 ft. of sewers. Geo. W. Lenhart.

NORRISTOWN, PA.—Bids are asked by the council for constructing a sewer in Noble St.

SCRANTON, PA.—The city engineer is preparing plans for a system of 24-in. pipe sewers for the south side.

BALTIMORE, MD.—Bids are asked until Aug. 20 for furnishing materials for a sewer in Fort Ave. A E. Smyrk, Cy. Comr.

CHARLOTTESVILLE, VA.—Bids are asked until Aug. 30 for constructing pipe sewers in districts Nos. 3, 4 and 5, as stated in our advertising columns. The itemized bids received for constructing the sewers in district No. 1 were published Aug. 9. Engr., N. Wilson Davis; F. M. Mills, Chn. Com.

FAIRMONT, W. VA.—Potter & Folwell, New York and Pittsburg, have been engaged to make plans for a system.

NEW BERNE, N. C.—The system was purchased at auction Aug. 6 for $5,100 by R. E. Walker, Concord, N. H., who has incorporated the New Berne Sanitary Sewer Co., with a capital stock of $50,000. T. A. Green and H. L. Gibbs, New Berne, are also interested.

MONTGOMERY, ALA.—Bids are asked until Sept. 3 for constructing 7,274 ft. of pipe and 11,899 ft. of brick sewers. R. H. Sommerville, Cy. Treas.

COVINGTON, KY.—Bids are asked until Sept. 3 for the purchase of $76,000 of Willow Run sewer bonds. J. T. Von Hoene, Cy. Clk.

AKRON, O.—It is proposed to construct sewers in three streets. E. A. Hershey, Cy. Clk.

NEWARK, O.—Bids are asked until Aug. 22 for constructing a pipe sewer in North Fifth St. W. A. Irvine, Cy. Clk.

SANDUSKY, O.—The council is considering the question of issuing $12,000 in bonds for a sewer in Columbus Ave.

SPRINGFIELD, O.—The following bids have been received for constructing pipe sewers in North Fountain Ave.: William Sharon, $5,466; Patrick Caffrey, $5,179; Ulrick, Nissley & Williams, $4,177; Azel B. Smith, $3,993 (awarded contract); Frank Whitley, $4,240; Patrick Welch & Joseph Bolan, $4,894; Martin Moran, $5,649.

KOKOMO, IND.—The council is discussing the construction of a system.

MINNEAPOLIS, MINN.—It is proposed to construct sewers in six streets.

MILWAUKEE, WIS.—Bids are asked until Aug. 18 for constructing a pile foundation and a brick sewer thereon. G. H. Benzenberg, Cy. Engr.

SAN ANTONIO, TEX.—The citizens have voted to issue $500,000 in bonds for constructing the proposed system.

EVERETT, WASH.—The council is discussing the question of issuing bonds for $50,000 for sewers.

BERKELEY, CAL.—The trustees are discussing the construction of a system in the district lying between Dwightway and Lorain.

OAKLAND, CAL.—An election will be held Sept. 1 in the Golden Gate Sanitary District to vote on the question of issuing $40,000 in bonds for constructing sewers.

STREETS.

ALBANY, N. Y.—Bids are asked until Aug. 20 for paving Quail St. with brick. T. J. Lanahan, Clk.

BROOKLYN, N. Y.—Bids are asked until Aug. 24 for paving one street with granite blocks, and two streets with cobblestones. A. T. White, Comr. Cy. Wks.

DUNKIRK, N. Y.—Bids are asked until Aug. 30 for paving or macadamizing in Central Ave., 8,800 sq. yds., as stated in our advertising columns. J. M. Hackett, Cy. Engr.

NEW YORK, N. Y.—Bids are asked by the department of public parks until Aug. 22 for furnishing 4,000 cu. yds. of screened gravel, 1,580 gross tons asphalt mastic, 152 gross tons refined bitumen or paving cement, etc., for work in Central Park.

SYRACUSE, N. Y.—The council has been petitioned to pave Mulberry St. with asphalt for a distance of 1½ miles.

ALTOONA, PA.—It is reported that the council will be petitioned to pave West Chestnut St. with brick, and to pave 16th St. with asphalt.

WASHINGTON, D. C.—Bids are asked by the district commissioners until Aug. 30 for grading and graveling, as stated in our proposal columns.

JACKSONVILLE, FLA.—The board of public works has passed an ordinance to pave Main St. with brick. W. C. West, Recdr.

LOUISVILLE, KY.—Bids are asked by the board of public works until Aug. 27 for improving portions of sidewalks in 11 streets.

CINCINNATI, O.—Bids are asked by the board of administration until Sept. 6 and 8 for paving with asphalt, one street at each date.

CLEVELAND, O.—Bids are asked until Sept. 12 for paving Dennison Ave. with brick. J. H. Farley, Dir. Pub. Wks.

CLEVELAND, O.—The council has received the following bids for paving two streets:

	Wason St., stone.	Marquardt St., brick.
M. F. Bramley	$19,254	$5,613
Burgess & Gribben	20,521	4,718
M. I. DeCelle	20,217	8,047
Albion Stone Co.	20,541	....
Roehl Bros.	20,774	4,682
William H. Patchett	20,875	5,315
The N. O. Pav'g & Constr'n Co.	21,262	5,708
J. F. Brennan	22,337	....
R. P. Burnett	22,632	....
Buettner & Orley	.....	4,743
Peter Rothenbecker	.....	5,390

COLUMBUS, O.—Bids are asked until Aug. 18 for paving three streets. J. A. Fanning, Clk.

DAYTON, O.—Bids are asked until Sept. 4 for 19,350 sq. yds. of paving with asphalt, Medina blocks or brick. C. A. Herbig, Cy. Comptroller.

MANSFIELD, O.—Bids are asked until Sept. 1 for improving three streets. F. M. Remy, Cy. Clk.

MARION, O.—Bids are asked until Aug. 20 for constructing sidewalks in George St. and for grading East St. James Williams, Cy. Clk.

PIQUA, O.—Bids are asked until Aug. 20 for asphalt or brick paving. Seth McCollock, Cy. Clk.

BRIGHTWOOD, IND.—The clerk has been directed to advertise for bids for improving Division St.

MUNICE, IND.—Bids are asked until Aug. 27 for constructing brick sidewalks, and until Sept. 3 for improving Elm St. F. A. Elrod, Cy. Clk.

SOUTH BEND, IND.—Bids are asked until Aug. 27

for grading and curbing Jefferson St. L. A. Hull, Cy. Clk.

SAGINAW, MICH.—The council has adopted ordinances for reconstructing plank sidewalks (39 contracts).

CHICAGO, ILL.—The Garden City Portland Cement Paving Co. has been incorporated, with a capital stock of $5,000, by W. R. White, M. L. White and S. V. A. White.

QUINCY, ILL.—Bids are asked, according to reports, for brick paving, estimated to cost about $30,000.

KANSAS CITY, MO.—The council has passed resolutions for paving about a mile of 14th St. with asphalt. If the board of public works consents, the work can be done this year.

APPLETON, WIS.—The council has directed that bids be asked for paving two streets with cobblestones and two streets with cedar blocks.

MINNEAPOLIS, MINN.—The aldermen have voted to pave Nicolle Ave. with cedar blocks for a distance of 3,889 ft.

ST. PAUL, MINN.—The council has voted to pave Seventh St., between Brook St. and Seven Corners, with asphalt.

SEATTLE, WASH.—An ordinance has been introduced in the board of aldermen for the replanking and improving of 70 blocks.——The contract for grading Harrison St. has been awarded to Taylor Bros. and Holt & McDonald at $8,268, the other bids being J. F. Garrety, $10,505, and E. G. Smart, $9,171.

TORONTO, ONT.—The council has passed an ordinance for constructing an asphalt pavement in Adelaide St. estimated to cost $14,800. John Blevins, Cy. Clk.

ELECTRIC LIGHT AND POWER.

DOVER, ME.—The Dover & Foxcroft Electric Light Co. has purchased the water power on Piscataquis River at East Dover and will use it for furnishing electricity for the two villages.

GORHAM, N. H.—P. Kellogg, Whitefield, is reported to have been awarded a contract to put in an electric light plant, to cost about $12,000.

MORRISVILLE, VT.—The question of building or authorizing the construction of an electric light plant is being discussed.

NEW YORK, N. Y.—Bids are asked by the department of public charities and correction, 66 Third Ave., until Aug. 22 for materials and work for wiring for the electric light plant of the main and branch insane asylums, Ward's Island.

MANLIUS, N. Y.—Edward Kanaley is reported as organizing a company to put in an electric light plant at Edward's Falls for the purpose of furnishing light for East Syracuse, Fayetteville, Eastwood Heights and this place, for which he has obtained a franchise.

MILLERSBURG, PA.—It is reported that this place will soon have electric lights.

TOWSON, MD.—The question of electric lights is being discussed.

LYNCHBURG, VA.—The council is discussing a proposition to put in a municipal electric light plant, estimated to cost $60,000.

CARONGTON, O.—The council has contracted for an electric light plant of 300 incandescent and 32 arc lights.

LANCASTER, O.—Bids are asked until Sept. 14 for an electric light plant at the boys' industrial school. C. D. Hilles, Secy.

CHESANING, MICH.—The citizens are reported to have voted in favor of electric lights.

ALTON, ILL.—The Alton Gas & Electric Light Co. is reported as about to erect a brick addition to the power house, which will be furnished with a 125-HP. boiler and 200-HP. Corliss engine. The capacity of the plant will be increased from 1,500 incandescent lamps to 3,000.

FULLERTON, NEB.—A company is reported to have been organized and to have been granted a 10-year franchise for electric street lighting.

FLORENCE, COLO.—An election will be held Sept. 10 to vote on the question of granting a franchise to the Florence Electric Light Co.

SALT LAKE CITY, UTAH.—L. C. Trent & Co. have proposed to the council to put in an electric light plant of 600 HP., incandescent dynamos for 1,500 lights of 16 c. p., 300 arc lights of 2,000 c. p., etc., to cost $100,000, and to cost $1,800 a month to operate.

NEW COMPANIES.—Citizens' Electric Co., Springfield, Ill.; $60,000; John McCreery, F. D. Buck, L. H. Coleman.——United Telegraph, Telephone & Electric Co., Chicago, Ill.; $1,000,000; Donald McDonald, J. G. Earle, E. P. McConnell.——Crown Point Electric Co., Crownpoint, Ind.; $10,000; G. K. Wheeler, E. S. Tice, O. H. Olsen.——Towle Vault Light Co., New York; $25,000; William Towle, Frank Cox, Brooklyn.——Citizens' Electric Light & Power Co., Appleton, Wis.; $10,000.——Rockport Electric Power, Light & Heat Co., Kittery, Me.; furnishing light and heat in Rockport, Mass.; $50,000; Pres., R. H. Tarr, Rockport; Treas., J. B. Stevens, Lynn.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

BONDS.—Norwood, O.—Bids are asked until Sept. 7 for the purchase of $14,362 in 6% street widening bonds. W. E. Wichgar, Clk.

CISTERN.—Columbus, O.—Bids are asked until Aug. 21 for the construction of a 1,000-bbl. fire cistern. Jas. A. Fanning, Clk. Bd. Pub. Wks.

LEVEE WORK.—Delta, La.—Bids are asked by the fifth levee district until Aug. 22 for 608,000 cu. yds. of work, eight contracts. W. H. Shields, Secy.

RESETTING BOILERS.—New York, N. Y.—Bids are asked by the department of charities, 66 Third Ave., until Aug. 22 for resetting five boilers on Ward's Island.

CANAL WORK.—Ottawa, Ont.—Bids are asked until Sept. 4 for the deepening of the canal prism between lock No. 3 and lock No. 5. J. H. Balderson, Secy., Dept. of Rys.

DITCH WORK.—Wapakoneta, O.—Bids are asked until Aug. 17 for the excavation of the Metz joint ditch (43 sections), about nine miles east of this city. Samuel Craig, Engr.

ENLARGING ISLAND.—New York, N. Y.—Bids are asked by the commissioners of quarantine until Aug. 24 for the enlargement of Hoffman Island, as stated in our advertising columns.

COURT ROOM AND JAIL.—Ottawa, Ont.—Bids are asked until Aug. 27 for the erection of a court room and jail at Mattawa, Nipissing district. Wm. Harty, Comr., Dept. Pub. Wks.

JAIL, ETC.—Phillips, Wis.—Bids are asked until Aug. 22 for the erection of a county jail and sheriff's residence, and until Aug. 23 for a court house. G. M. Chamberlain, Clk. Price County.

BUILDINGS.—Franklin, Pa.—Bids are asked until Aug. 30 for the erection of buildings for the state institutions for the feeble-minded. Arch., F. J. Osterling, Pittsburg; Norman Hall, Secy.

WHARVES, ETC.—Portsmouth, Va.—Bids are asked until Aug. 21 by the Atlantic & Danville Ry. Co. for the construction of three wharves and one warehouse at West Norfolk, Va.; also for 40,000 cu. yds. of dredging.

PIERS AND DREDGING.—New York, N. Y.—Bids are asked by the department of docks until Aug. 30 for building wooden piers at the foot of East 60th and 61st Sts., East River, and for about 100,000 cu. yds. of mud dredging.

CHANNEL DREDGING.—Block Island, R. I.—The contract for dredging a channel 400 ft. long and 15 ft. deep to connect the Great Salt Lake with the ocean has been awarded to the Hartford Dredging Co. It is stated that the work will cost $50,000.

POWER HOUSE AND OFFICE BUILDING.—Detroit, Mich.—Col. O. M. Poe, U. S. Engr. Office, received the following bids July 28 for a power house and office building for the 800-ft. lock, St. Mary's Falls canal:

Bids Received for Power House and Office Building for the 800-ft. Lock, St. Mary's Falls Canal, Mich.

Bidder.	Mason work.	Iron and steel work.	Metal roofing.	Carpenter work.	Plastering.	Plumbing.	Steam heating.	Electric light.	Elevator.	Painting.	Total with south basement wall of brick or concrete.	Total with south basement wall of lime stone masonry.
	$	$	$	$	$	$	$	$	$	$	$	$
Joseph V. Gearing, Detroit, Mich.	79,391	17,000	1,300	7,116	4,370	2,600	2,400	1,400	1,450	500	117,527	118,807
Frank H. Goddard, Detroit, Mich.	82,300	17,940	1,278	7,800	3,931	2,649	2,468	1,375	1,530	2,000	123,271	127,071
HughesBros.& Bangs,Syracuse,NY.	83,000	17,425	1,350	9,000	5,200	2,300	2,400	1,400	1,600	600	124,275	124,275
Benjamin Hyde, Chicago, Ill.	93,600	14,620	1,530	9,000	4,250	2,680	2,240	1,550	1,740	590	131,800	136,000
John Griffiths, Chicago, Ill.	88,000	19,963	1,622	7,900	3,500	4,800	2,600	3,000	1,800	1,800	134,985	134,985
[1] J. L. Lipsett & Robt. Gregg,	96,207	27,500	1,375	9,300	5,360	2,230	2,390	1,475	1,530	550	144,218	147,918

[1] Sault Ste. Marie, Mich.

CITY HALL AND MARKET.—Jacksonville, Fla.—Bids are asked until Sept. 10 for the construction of a city hall and market building. Arch. John R. Scott, Board of Trade Bldg.

DREDGE.—Ottawa, Ont.—Bids are asked until Aug. 31 for the construction and delivery of a spoon dipper dredge, having steel hull, steel boom and compound surface condensing engines for salt water service. E. F. E. Roy, Secy. Dept. Pub. Wks.

TELEGRAPH LINES.—Washington, D. C.—Bids are asked until Aug. 20 for the purchase of 30 miles of telegraph line extending from Wilmington to Southport, N. C., and 130 miles from Titusville to Jupiter, Fla., J. Sterling Morton, Secy. Dept. of Agriculture.

DREDGING.—Boston, Mass.—Bids are asked until Aug. 17 for dredging bars in the Concord and Sudbury rivers, in the towns of Concord, Wayland, and Sudbury; distance, 14 miles; appropriation, $20,000. S. W. Abbott, Secy., State Bd. of Health, 13 Beacon St.

METAL WORK AND BUILDINGS.—New Orleans, La.—Bids are asked until Sept. 11 for the metal work for the Crooked River light station, Florida, as stated in our advertising columns; also for the erection of the buildings. Maj. James B. Quinn, U. S. Engr. Office.

ELECTRICAL SUBWAY CONDUITS.—Baltimore, Md.—Bids are asked until Sept. 1 for a system of electrical subway conduits, of either creosoted wood, treated wrought iron pipe, cement lined tubes or terra cotta tubes, laid in concrete. Engr., N. S. Hill, Jr., Equitable Bldg.

DRAINAGE.—Monroe, La.—The council has contracted with E. Fudickar, Monroe, to drain this city. The work will include the construction of a drainage canal which is to be completed Oct. 1, 1895, and kept in repair for eight years, during which time Mr. Fudickar will receive the proceeds of a 1½ mill tax levied for this purpose, estimated at $18,000 for the eight years.

TELEPHONE FRANCHISES.—Waukegan, Ill.—The D'Unger Long Distance Telephone Co. has been granted a franchise, prices not to exceed $25 for residences and $35 for offices.

Pen Argyl, Pa.—A franchise has been granted to the Pennsylvania Telephone Co.

Delaware, O.—A telephone franchise is reported to have been awarded to a new company.

Massillon, O.—The council is arranging with the Farmers' Telephone Co. to extend its Lebanon line to this city. It is stated that the council will be given eight telephones free and a reduction of 25% to councilmen.

CONTRACT PRICES.

PIPE.—Hoboken, N. J.—The following bids were received Aug. 7 for furnishing 75 tons of 6-in. cast iron water pipe, according to local papers: McNeal Pipe & Foundry Co., $22.75 per ton; M. J. Drummond, $22.50; Jersey City Supply Co., $22; John Warren, $23; John Fox, $21.00; Jackson & Woodin, $21.56; C. Millar, $23.52; Pflugh Bros., $24.96; Rogers, Brown & Co., $25.76; R. D. Wood & Co., $23.40.

Troy, N. Y.—The "Times" states that the water board has contracted with Chas. Millar & Son, Utica, for 750 ft. of 6-in. pipe, at $22.40 per gross ton. Bids were asked for 500 ft., and the other bids were as follows: R. D. Wood & Co., $24.80 per gross ton; Radford Pipe & Foundry Co., $21.60 per net ton; Warren Foundry & Machine Co., $21.60 per gross ton, f. o. b. cars at Pittsburg.

PUMPING ENGINES.—Henderson, Ky.—The council has contracted with the Laidlaw-Dunn-Gordon Co., Cincinnati, for a 2,000,000-gallon compound pumping engine, for $2,350. It will be of the latest design, Gordon style.

Lewiston, Me.—The water board is reported to have received the following bids for furnishing a 3,000,000-gallon pumping engine:

Deane Steam Pump Co. (awarded contract)	$5,900
E. P. Allis Co.	6,500
Henry R. Worthington	7,770
Geo. F. Blake Mfg. Co.	11,800
Knowles Steam Pump Wks.	13,500

St. Bernard, O.—Geo. Hornung, Consult. Engr., Cincinnati, informs us that the contract for two horizontal compound pumping engines, 11½ × 18½ × 9½ × 18 ins., has been awarded to the Laidlaw-Dunn-Gordon Co. The bids were as follows, (1) being the prices bid for the pumping engines, (2) for four vertical engines for 8-in. tube wells, (3) for one 6 × 4 × 6-in. duplex feed pump, and (4) the total; all bidders residents of Cincinnati:

	1.	2.	3.	4.
John H. McGowan Co.	$2,800	$980	$100	$3,880
Laidlaw-Dunn-Gordon Co.	3,907	1,200	100	5,207
Price,Gaither&Price(inf'm'l)	4,500	....	120	....

STAND-PIPE AND FOUNDATION.—Glendale, O.—Chas. B. Going, Secy. Bd., writes us that the following bids were received for the proposed stand-pipe, the contract being awarded to L. Schreiber & Sons Co., Cincinnati, O., at $3,667; stand-pipe will be 17 × 80 ft. and built of open hearth steel:

	Plain.	Ornamental top.	With gallery and spiral stairway.
R. S. Munroe & Son	$2,900	$3,255	$3,750
The Brownell Co., Dayton, O.	....	3,755	....
L. Schreiber & Sons Co.	2,593	3,068	3,667
Stacey Mfg. Co., Cincinnati.	2,516	....	3,995
Mansfield Machine Works.	....	3,227	....
Riter & Conley, Pittsburg,Pa.	2,600	....	4,220

The contract for the foundation was awarded to F. E. Roach, for native limestone. The work will consist of 4 ft. of concrete, 4 ft. of cut stone masonry and a tower 30 ft. high, broken ashlar rock faced. The bids were as follows, the prices being per cu. yd.:

	Concrete, inc. excav. and Foundation back filling.	Tower m's'ry.	Tower m's'ry.	Rock proposed.
R. G. Houston	$3.75	$6.85	$8.50	Indiana.
F. E. Roach.	3.65	6.15	7.50	Greensburg.
F. E. Roach,	3.65	4.90	6.50	Native limestone.
J. H. Baumer.	4.85	8.50	7.50	Greensburg.
W. Graveson	5.25	8.75	11.00	Indiana.
W. Graveson	5.25	....	7.50	Native limestone.
James Nolan	4.90	6.50	9.00	Centerville stone.
A. Kalbfleisch.	3.60	8.65	10.00	Dayton limestone.
Bryan Flannery	6.50	10.00	7.00	Native limestone.
John Speng	4.35	7.75	11.25	Greensburg stone.

WATER-WORKS.—Fullerton, Neb.—G.H. Ellsworth, Engr., writes us that the contract for reservoir, pumping station and 5,700 ft. of 8-in. main, has been awarded to the U. S. Wind Engine & Pump Co. The city will probably put in about 6,000 ft. of 6 and 4-in. mains by day labor. The bids for furnishing and laying pipe, per lin. ft., hydrants and valves, were as follows:

Bids for Constructing Water-Works at Fullerton, Neb.

Bidder.	Pipe. 8-in.	Pipe. 6-in.	Pipe. 4-in.	Hydrants.	Valves. 6-in.	Valves. 4-in.	Complete.
J. A. Barris & Co., Council Bluffs.	$1.25	$1.06	$0.76	$26.00	$19.00	$13.25	$9,031
Fremont Foundry & Mach. Co., Fremont, Neb.	.73	.53	.39	27.00	13.50	9.00	9,500
Atkinson Bros., Colorado Springs, Colo.	.78	.58	.45	29.00	22.00	15.00	10,349
U. S. Wind Engine & Pump Co., Batavia, Ill.	.80	.50	.43	30.00	17.00	14.00	8,500
E. A. Rudiger, Nebraska City.	.68	.55	.42	28.00	17.00	13.00	9,830
M. L. Wolfe & Co., Cedar Rapids, Neb.	.81	.60	.43	32.00	12.00	11.00	10,000
Kennedy & McKee, Fullerton, Neb.	.70	.70	.55	31.50	20.00	16.00	9,667
Novelty Plumbing & Engine Wks., Sioux City.	..	.56	.42	45.00	35.00	....	9,700

BRICK PAVING.—Easton, Pa.—The contract for paving Washington St. west from Ninth St. with vitrified brick has been awarded to the Standard Construction Co., Easton, at $2.18 per sq. yd.

PUMPING ENGINES AND BOILERS.—Carey, O.—The following bids were received Aug. 1 for (1) two 500,000-gallon duplex compound pumping engines, set ready for use; (2) feed pump and heater; and (3) boilers and fixtures, two 60 ins. × 16 ft.; Engr., J. S. Humphry, Findlay, O.:

	1.	2.	3.
Adams Bros. Co.	....	....	$1,530
" " less masonry.	....	....	1,252
*Comins Mfg. Co.	....	....	1,220
**Hughes Steam Pump Co.	$2,000	$250	2,000
Henry R. Worthington.	2,650	150	....
Laidlaw-Dunn-Gordon Co.	2,300	225	2,180
"	2,033	....	2,400
"	2,600	....	....
Barr Pumping Engine Co.	2,100	186	2,300
J. H. McGowan Co.	2,245	270	....

*Not including labor of setting.
**Lumped bid of $4,000 if awarded.

ASPHALT PAVING.—Dayton, O.—F. M. Turner, Cy. Engr., writes us that the following bids were received July 30 for paving with asphalt, the price being per square yard for the work complete, including 6-in. concrete foundation; bidders were (1) Warren-Scharf Asphalt Paving Co., New York, and (2) Trinidad Asphalt Paving Co., Dayton:

Jefferson St.	$2.62	$2.66
Webster St.	2.63	2.68
State St.	2.61	2.66
Walnut St.	2.61	2.66
Fremont Ave.	2.61	2.66
Sears St.	2.63	2.70
Taylor St.	2.63	2.66
Bainbridge St.	2.61	2.66
Meigs St.	2.64	2.68
Toledo St.	2.66	2.70

DITCH EXCAVATION.—Wapakoneta, O.—Samuel Craig, Engr., writes us that the contracts for the Pusheta Creek improvement have been awarded as follows, the prices being per cubic yard:

G. W. Line, St. Johns, O., secs. 1 to 6, at	7.78 cts.
W. J. Dull, Arcanum, secs. 7 to 13, at	11.52 "
Myers & Pohlschneider, Sidney, O., 14 to 22.	13.27 "
B. W. Decker,* Buckland, O., secs. 23 & 24, at.	17.4 "
Samuel Beard,* St. Johns, O., sec. 25, at	17.4 "
B. W. Decker,* Buckland, O., secs. 26, 27, 28.	13.5 "
Lee Harner,* Lewistown, O., secs. 29, 30, at.	12.3 "
William Wright,* Celina, O., sec. 31, at	13.4 "
Sec. 32, open work, at	6.93 "
Charles M. Howell, Wapakoneta, O., secs. 33, 34, at	11.8 "

* Tile trench and laying tile; tile to be delivered on ditch bank.

SEWERS.—Urbana, Ill.—The contract for proposed sewers has been awarded to the Dubuque Construction Co., as stated in our issue of Aug. 7. Engr., A. N. Talbot, Champaign. The bids were as follows:

SEWERS.—Toledo, O.—Lem P. Harris, Cy. Clk., writes us that the following contracts were awarded Aug. 6 for constructing brick sewers:

Wm. J. McMahon 20-in., 701 ft., at	$782
F. E. Cole, 24-in., 1,283 ft. at	1,380
" " " 24-in., 1,375 " "	1,757
T. Kelly, 24-in., 1,315 " "	1,641

PIPELAYING, ETC.—St. Bernard, O.—Geo. Hornung, Consult. Engr., informs us that the contract for laying the water pipe, setting hydrants, etc., for the new water-works has been awarded to R. N. Andrews, the bids being as follows:

Bids for Laying Water Pipe, Setting Fire Hydrants, Etc., St. Bernard, O.

Bidder.	Pipe. 10-in.	8-in.	6-in.	4-in.	Hydrants.	Extra excav.	Total.
Roughen Engineering Co., Cincinnati, O.	$0.28	$0.20	$0.15	$0.13½	$1.25	$0.20	$6,931.65
Wilson, Smith & Coon, Saltsburgh, Pa.	.26	.22½	.18½	.17½	3.50	.19	8,348.05
Toledo Construction Co., Toledo, O.	.18	.15	.11	.10	2.00	.30	5,201.30
A. H. Newell, Cincinnati, O.	.40	.30	.23	.18	4.00	1.00	10,648.10
Carothers & Crane, Cincinnati, O.	.24	.17	.16	.14¾	.75	.20	6,989.95
P. Murray & Sons, Cincinnati.	.21	.19	.16½	.14¼	4.00	.35	7,218.65
William White, Newport, Ky.	.18	.16	.13	.11	.01	.25	5,695.81
Nesbeth, Wingfield & Co., Chattanooga, Tenn.	.20	.18	.14	.13	2.00	.30	6,397.40
C. N. Danenhower, Cincinnati, O.	.27	.22	.18	.16	6.00	.30	8,242.00
R. N. Andrews, Hamilton, O.	.18¾	.15¼	.13¼	.10¾	.87	.20	5,544.20
H. Merigold, Lima, O.	.20	.18	.15	.13	5.50	.20	6,088.20
D. R. P. Dimmick, Newport, Ky.	.18	.17	.15	.11½	.50	.20	6,062.60
John Ryan, Reading, O.	.18	.16¾	.12½	.10¾	3.50	.40	5,769.55

LEVEE WORK.—Vicksburg, Miss.—The board of the fifth Louisiana levee district has awarded the following contracts: Marshall levee in Tensas parish, about 12,000 cu. yds., to the Eltringhorn Construction Co., Natchez, at 16.73 cts. per cu. yd.; Buckhorn levee, in Madison parish, about 15,000 cu. yds., to Robert Nicholson, at 13.21 cts.; Milliken's Bend to Nebraska, 65,000 cu. yds., to John Scott & Sons, at 12.74 cts.; Willow Slough levee, in Madison, 75,000 cu. yds., John Scott & Sons, at 12.74 cts. per cu. yd.; Towne levee, in Madison parish, 11,000 cu. yds., to John Scott & Sons, at 12.74 cts.; Bruin's Bayou levee, in Tensas parish, 17,000 cu. yds., to John Scott & Sons, at 12.74 cts.

HYDRANTS, VALVES, ETC.—St. Bernard, O.—Geo. Hornung, Engr., Cincinnati, informs us that the following bids were received last month for furnishing hydrants, valves, etc., for the water-works; bids for 680 tons of 10 to 4-in. pipe were published May 31, contract being awarded to the Anniston Pipe & Foundry Co., at $16.95 per ton for pipe and $42.50 for specials:

Bids for Fire Hydrants, Valves, and Valve Boxes for St. Bernard, O., Water-Works.

Bidder.	Hydrants a	Hydrants b	Valves. 10-in.	8-in.	6-in.	4-in.	90 ext'n v. b'xes	Total. a	Total. b
*Bourbon Cop'r & Brass Wks. Cincinnati	$40.50	$28.50	$22.50	$17.00	$10.75	$6.75	$2.50	$3,258.75	$2,646.75
Ludlow Valve Mfg. Co., Troy, N. Y.	33.50	25.00	23.45	15.90	10.63	6.40	2.90	2,926.13	2,492.63
R. Hesterberg & Bro., Cincinnati.	39.55	28.00	21.00	16.00	9.50	6.00	2.75	3,133.05	2,544.00
Mich. Brass & Iron Wks., Detroit.	34.25	26.25	21.50	15.00	10.40	6.40	2.45	2,893.85	2,332.85

* Awarded contract at $3,250. a, 51 fire hydrants with secondary valves. b, 51 fire hydrants without secondary valves.

CEMENT.—New York, N. Y.—The contract for 8,000 bbls. of Portland cement, recently noted, has been awarded by the department of docks, to the Atlas Cement Co., at $1.82 per bbl. This was the only bid received.

Bids Received for Constructing Sewers at Urbana, Ill.

Bidders.	Trenching and backfilling 0 to 4 ft.	4 to 6 ft.	6 to 8 ft.	8 to 10 ft.	10 to 12 ft.	12 to 14 ft.	14 to 16 ft.	Vitrified pipe sewer 12-in.	10-in.	8-in.	C. I. pipe sewer 12-in.	10-in.	Embankment, Base.	Embankment, Covr	Haul per 100 ft.	Manholes, 8 ft. deep.	Flush tank, 800 gals.	Flush tank, 200 gals.	Lamp-holes, deep.	Lamp-holes, deep[1]	Brick manhole, 8 ft.	House drains.	Total.
Dubuque Const'n Co., Dubuque, Ia.	$.05	$.08	$.15	$.23	$.30	$.37	$.45	$.20	$.15	$.10	$1.50	$1.00	$.20	$.20	$.01	$25.00	$50.00	$40.00	$8.00	$4.00	$15.00	$.17	$6,864.20
William Davy, Kenosha, Wis.	.05	.10	.12	.20	.30	.40	.60	.21	.19	.14	1.20	.90	.27	.23	.01	23.00	30.00	20.00	4.50	.56	9.00	.30	7,709.88
G. B. Kelley, Chicago, Ill.	.13	.16	.19	.24	.30	.38	.50	.24	.20	.18	1.90	1.40	.25	.17	.02	23.00	75.00	58.00	4.75	4.00	12.25	.20	8,480.07
T. W. Kinder & Sons, Terre Haute.	.10	.15	.20	.25	.30	.40	.50	.25	.20	.15	2.50	2.50	.40	.40	.02	25.00	40.00	30.00	10.00	4.00	15.00	.20	8,729.00
Philip Steele, Urbana, Ill.	.08	.12	.19	.27	.37	.48	.60	.28	.22	.15	1.90	1.50	.28	.18	.01	25.00	60.00	50.00	7.00	2.00	13.00	.22	8,787.54
Alfred E. Reid, Champaign, Ill.	.08	.14	.20	.35	.45	.50	.60	.30	.28	.18	1.50	1.45	.10	.10	.02	25.00	70.00	30.00	6.00	3.20	6.00	.10	9,055.78
Mall & Doan, Aurora, Ill.	.15	.20	.25	.30	.35	.40	.50	.25	.22	.17	1.25	1.00	.30	.30	.01	28.00	70.00	30.00	5.00	4.80	7.00	.40	10,402.72
[2]Ulrick, Nissley & Williams.	.05	.10	.15	.50	.60	.75	.90	.22	.20	.16	1.00	1.00	.25	.25	.02	30.00	100	50.00	5.00	4.00	10.00	.40	10,426.64
A. Magnus, Elgin, Ill.	.14	.15	.15	.40	.52	.80	.95	.25	.21	.16	3.00	2.75	.25	.25	.01	24.00	80.00	60.00	6.00	2.40	14.00	.30	10,915.96
Rockford Const'n Co., Rockford, Ill.	.10	.12	.18	.25	.35	.45	.50	.42	.36	.29	1.50	1.25	.25	.25	.01	40.00	100	60.00	12.00	2.00	12.00	.30	11,885.68
Jesse Robertson, TerreHaute, Ind.	.20	.25	.35	.50	.65	.72	.95	.35	.30	.25	2.50	2.00	.50	.50	..	24,00	100	50.00	10.00	4.00	8.00	.30	13,352.60

[1] Temporary lampholes. [2] Springfield, O.

Albany, N. Y.—Thos. J. Lanahan, Clk. Bd. of Contract, writes us that contracts for constructing vitrified pipe sewers were awarded as follows Aug. 6: State St. sewer, to P. H. Reilly, at $1,467; Lake Ave., to John Doyle, at $289; Beaver St., to Peter Callanan, at $4,307; Clinton St., P. H. Reilly, at $1,956. The bids for the sewer in Clinton St. were as follows, the bidders being (1) R. H. Strong, 236 Washington Ave., city; (2) John Doyle, 66 Park Ave.; (3) Wm. J. McCann, 117 Elm St.; (4) P. H. Reilly, 107 Philip St.:

	1.	2.	3.	4.
20-in. pipe, per lin. ft.	$1.50	$1.39	$1.68	$1.45
12-in. " "	1.00	.95	.93	1.00
6-in. " "	....	.15	.40	.14
20-in. Y's, each	5.25	4.45	5.00	4.00
12-in. " "	2.55	2.48	2.28	2.50
Extra trench, per lin. ft.	.05	.05	.01	.05
Manholes, each	60.00	50.00	53.00	45.00
Lampholes, "	12.00	12.50	12.00	14.00
Lateral trench, per lin. ft.	.60	.50	.50	.25
Hse. dr'n trnchs. "	.40	.35	.75	.35
Total	Informal	$2,306	$2,928	$1,956

Green Bay, Wis.—Swend Mord has been awarded contracts for several pipe sewers at 28 cts. per lin. ft. for 8-in., 32 cts. for 10-in., 23 cts. for laterals and $4 each for circular walls.

Pittsburg, Pa.—I. P. Bingaman, Ch. Clk., Dept. Pub. Wks., writes us that contracts for constructing sewers have been awarded as follows:

Contracts for Sewers Awarded at Pittsburg, Pa., Aug. 1, 1894.

	9-in.	15-in.	18-in.	20-in.	24-in.	[1]30-in.	Drops.	Manholes.
Geo. F. Egan, Pittsburg, Pa.	$0.59	$0.80 to $1.00	$1.63	$1.83	....	....	$45.00 to $50	$25.00 to $30.00
[2]Sloan, McIlvain & Ott Bros.	...	1.25 " 1.60	....	1.47	$2.45	....	$60.00	30.00 " 38.00
T. J. Swain, Pittsburg, Pa.	...	.88 " .98	....	....	....	....	56.00	$28.00
P. J. Flynn, Allegheny, Pa.	...	1.13 " 1.75	....	....	....	....	60.00	40.00
J. H. McQuade, Pittsburg, Pa.	...	$1.72	1.33	....	1.32	3.45	50.00 to 60	30.00 to 40.00
Cone Ascelto, Pittsburg, Pa.	...	1.04 to 1.65	....	....	1.00	....	56.00	28.00
P. O'Donnell, Pittsburg, Pa.	...	1.40	....	....	....	....	....	28.00
Evan, Jones, Pittsburg, Pa.	...	1.00	....	....	....	....	58.00	26.00
John Sweeny, Pittsburg, Pa.	...	.98	....	....	....	....	55.00	30.00
Keeling, Ridge & Co., Pittsb'g	...	.93	....	....	....	....	65.00	25.00

[1] Brick and stone. [2] Allegheny, Pa.

GAS COMPRESSORS.—Findlay, O.—C. A. Stockton, Pres. Mutual Gas Dept., writes us that the city has contracted with the Laidlaw-Dunn-Gordon Co., Cincinnati, for two gas compressors, 30-in. diameter by 30-in. stroke, at $2,742; this price including all work and everything necessary to making a satisfactory connection with present plant.

PIPELAYING, ETC.—Carey, O.—The following bids were received Aug. 1 for laying pipe, setting valves and hydrants and for the complete construction of the proposed water-works; Engr., J. S. Humphrey, Findlay:

	12-in.	10-in.	8-in.	6-in.	4-in.	Complete plant.
Phillips & Bixel.	$.26½	$.25	$.19	$.14	$.12½	.....
Thos. H. Botham	.25	.22	.20	.17	.15	$26,866
Z. T. Darrow	.22	.19	.16	.12	.10¾	26,927
H. D. Shannon	.24½	.22	.19	.17	.14	26,900
Chandley Bros. & Co.	.40	.35	.25	.20	.18	28,500
A. Tubman	.27	.21	.15	.13¼	.10	27,500
Shaw-Kendal Co.	.35	.30	.21	.16	.14	25,882
Snyder & Frederick.	.20	.19	.14	.13	.10	24,900

CONDENSED LIST OF CONTRACTS PENDING WITH DATE OF OPENING BIDS.

Bids to be opened.	Work.	Place.	See Eng. News.
Aug. 17.	Pipe sewers (1,559 ft.),	Avondale, O.	July 26
Aug. 17.	Stone paving,	Brooklyn, N. Y.	Aug. 9
Aug. 17.	Dredging, etc.,	Albany, N. Y.	Aug. 9
Aug. 17.	Dredging,	Boston, Mass.	Aug. 16
Aug. 17.	Ditch work,	Wapakoneta, O.	Aug. 16
Aug. 18.	Water ext'n bonds ($2,000),	Clifton, O.	Aug. 2
Aug. 18.	Pipe sewers (6,100 ft.),	Lawrence, Kan.	Aug. 9
Aug. 18.	Brick sewer upon piles,	Milwaukee, Wis.	Aug. 16
Aug. 18.	Elec. power house, etc.,	Conway, Mass.	Aug. 16
Aug. 18.	Paving,	Columbus, O.	Aug. 16
Aug. 20.	Cement, Advertised, Eng. News, Aug. 2 to 16.	Pittsburg, Pa.	Aug. 2
Aug. 20.	Water-works system,	Morganfield, Ky.	Aug. 2
	Advertised, Eng. News, Aug. 2 to 16.		
Aug. 20.	Paving,	Toledo, O.	Aug. 2
Aug. 20.	Plans for jail,	Waukegan, Ill.	Aug. 2
Aug. 20.	Dams,	San Francisco, Cal.	Aug. 2
Aug. 20.	Asphalt blocks, etc., Advertised, Eng. News, Aug. 9 and 16.	Washington, D.C.	Aug. 9
Aug. 20.	Sewer brick, Advertised, Eng. News, Aug. 9 and 16.	Washington, D. C.	Aug. 9
Aug. 20.	Brick sidewalks,	Crawfordsville, Ind.	Aug. 9
Aug. 20.	Bridge bonds ($100,000)	Hamilton, O.	Aug. 9
Aug. 20.	Sewer materials,	Baltimore, Md.	Aug. 9
Aug. 20.	Brick paving,	Albany, N. Y.	Aug. 16
Aug. 20.	Brick sewers,	Jersey City, N. J.	Aug. 16
Aug. 20.	Iron pipe sewer, etc.,	Jersey City, N. J.	Aug. 16
Aug. 20.	Telegraph lines,	Washington, D. C.	Aug. 16
Aug. 20.	Sewer materials,	Baltimore, Md.	Aug. 16
Aug. 20.	Sidewalks,	Marion, O.	Aug. 16
Aug. 20.	Asphalt or brick paving,	Piqua, O.	Aug. 16
Aug. 21.	Sewers (27,485 ft.), Advertised, Eng. News, Aug. 9 and 16.	Plainfield, N. J.	Aug. 9
Aug. 21.	Paving bonds ($20,000),	Marion, O.	Aug. 9
Aug. 21.	Highway (6 miles),	Fortuna, Cal.	Aug. 9
Aug. 21.	Sewers,	Brooklyn, N. Y.	Aug. 9
Aug. 21.	Cistern,	Columbus, O.	Aug. 16
Aug. 21.	Sewers (4,900 ft.),	Brownsville, Pa.	Aug. 16
Aug. 22.	Drainage canal, Advertised, Eng. News, June 28 to Aug. 14.	Chicago, Ill.	June 28
Aug. 22.	Pmpg eng. house, etc.,	New York, N. Y.	July 26
Aug. 22.	Sewer work,	Cleveland, O.	Aug. 2
Aug. 22.	Pipe, hydrants, etc.,	Rushford, Minn.	Aug. 9
Aug. 22.	Asphalt (1,580 tons),	New York, N. Y.	Aug. 16
Aug. 22.	Gravel, etc.,	New York, N. Y.	Aug. 16
Aug. 22.	Resetting boilers,	New York, N. Y.	Aug. 16
Aug. 22.	Electric wiring,	New York, N. Y.	Aug. 16
Aug. 22.	Levee work (608,000 cu.yds.),	Delta, La.	Aug. 16
Aug. 22.	Pipe sewers,	Newark, O.	Aug. 16
Aug. 22.	Water-works system, Advertised, Eng. News, Aug. 16 and 23.	Fort Dodge, Ia.	Aug. 16
Aug. 22.	Jail,	Phillips, Wis.	Aug. 16
Aug. 23.	Artificial stone walks,	Cincinnati, O.	Aug. 2
Aug. 23.	Electric light plant, Advertised, Eng. News, Aug. 2.	Estherville, Ia.	Aug. 2
Aug. 23.	Highway bridge,	Omaha, Neb.	Aug. 2
Aug. 23.	Wharf repairs,	Blackbeard Isld. Ga.	Aug. 9
Aug. 23.	Sewer bonds ($35,000)	Hamilton, O.	Aug. 9
Aug. 23.	Highways,	Boston, Mass.	Aug. 16
Aug. 23.	Wells, etc., Advertised, Eng. News, Aug. 2 and 9.	Springfield, O.	Aug. 16
Aug. 23.	Court house,	Phillips, Wis.	Aug. 16
Aug. 24.	Fireproof building, Advertised, Eng. News, July 26 to Aug. 16.	Fairfax, Va.	July 26
Aug. 24.	Disinfecting plant,	Washington, D. C.	Aug. 2
Aug. 24.	Grading (12 miles),	Wapakoneta, O.	Aug. 2
Aug. 24.	Granite and cobistn pvg.,	Brooklyn, N. Y.	Aug. 16
Aug. 24.	Laying water pipe, Advertised, Eng. News, Aug. 16 and 23.	New York, N. Y.	Aug. 16
Aug. 24.	Water-works system,	Forreston, Ill.	Aug. 16
Aug. 24.	Enlarging island, Advertised, Eng. News, Aug. 16 and 23.	New York, N. Y.	Aug. 16
Aug. 24.	Tunnel sewer, Advertised, Eng. News, Aug. 16.	Niagara Falls, N. Y.	Aug. 16
Aug. 24.	Brick sewer, Advertised, Eng. News, Aug. 16.	Niagara Falls, N. Y.	Aug. 16
Aug. 21.	Wharves, etc.,	Portsmouth, Va.	Aug. 16
Aug. 21.	Water meters,	Montreal, Que.	Aug. 16
Aug. 25.	Dredging,	Wilmington, N. C.	Aug. 2
	Advertised, Eng. News, Aug. 2 to 23.		
Aug. 25.	Sewers,	Marietta, O.	Aug. 2
Aug. 25.	Fireboat,	Boston, Mass.	Aug. 9
Aug. 25.	Sewers,	Zanesville, O.	Aug. 9
Aug. 25.	Well, etc., Advertised, Eng. News, Aug. 9 to 23.	Austin, Tex.	Aug. 9
Aug. 25.	Bridge,	Troy, O.	Aug. 16
Aug. 25.	Reservoir, Advertised, Eng. News, Aug. 9 and 16.	Kittanning, Pa.	Aug. 16
Aug. 25.	Water-wks system,	Lancaster, Pa.	Aug. 16
Aug. 27.	Canal, etc. (5 miles), Advertised, Eng. News, Aug. 2 to 23.	Chicago, Ill.	Aug. 2
Aug. 27.	Bonds ($5,000),	Lamberton, Minn.	Aug. 9
Aug. 27.	Sidewalk improvemts,	Louisville, Ky.	Aug. 16
Aug. 27.	Brick sidewalks,	Muncie, Ind.	Aug. 16
Aug. 27.	Court room and jail,	Ottawa, Ont.	Aug. 16
Aug. 27.	Grading and curbing,	South Bend, Ind.	Aug. 16

Aug. 28. Removing wreck, Boston, Mass.....Aug. 2
Aug. 28. Water-wks system, Cedar Rapids, Neb. Aug. 9
Aug. 28. Disinfecting plant, San Diego, Cal....Aug. 9
Aug. 28. Water-works system, Alton, Ia.....Aug. 16
Aug. 29. Water-wks. system, Richmondville, N. Y. Aug. 16
Advertised, Eng. News, Aug. 16 and 23.
Aug. 30. Paving (8,800 sq. yds.), Dunkirk, N. Y. .Aug. 16
Advertised, Eng. News, Aug. 16 and 23.
Aug. 30. Grading, Washington, D. C.....Aug. 16
Advertised, Eng. News, Aug. 16 and 23.
Aug. 30. Pipe sewers, Charlottesville, Va.....Aug. 16
Advertised, Eng. News, Aug. 16 to 30.
Aug. 30. Dredging, New York, N. Y.....Aug. 16
Aug. 30. Buildings, Franklin, Pa.....Aug. 16
Aug. 30. Wooden piers, New York, N. Y.....Aug. 16
Aug. 31. Reservoir, Cambridge, Mass.....Aug. 2
Advertised, Eng. News, Aug. 2 and 9.
Aug. 31. Dredge, Ottawa, Ont.....Aug. 16
Sept. 1. Pipe, pump, etc., Honolulu, H. I.....July 19
Advertised Eng. News, July 19 to Aug. 2.
Sept. 1. Electric lighting, Portland, Ore.....June 21
Sept. 1. Electric lighting, Toronto, Ont.....Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Sept. 1. Electric light plant, Toronto, Ont.....Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Sept. 1. Pump'g engs., etc., Providence, R. I..Aug. 9
Advertised, Eng. News, Aug. 9 to 30.
Sept. 1. Water bonds ($10,000), Rushford, Minn. Aug. 9
Sept. 1. Electric subw'y cond't, Baltimore, Md. Aug. 16
Sept. 1. Street improvements, Mansfield, O.....Aug. 16
Sept. 3. Bridge, Dillon, Mont.....July 5
Sept. 3. Brick sewers, Montgomery, Ala.....Aug. 16
Sept. 3. Pipe sewers, Montgomery, Ala.....Aug. 16
Sept. 3. Sewer bonds, ($76,000), Covington, Ky. Aug. 16
Sept. 3. Street improvements, Muncie, Ind.....Aug. 16
Sept. 4. Asphalt or brick paving, Dayton, O.....Aug. 16
Sept. 4. Pumping plant, etc., Dekalb, Ill.....Aug. 16
Advertised, Eng. News, Aug. 16 to 23.
Sept. 4. Canal work, Ottawa, Ont.....Aug. 16
Sept. 5. Operating machinery, Detroit, Mich...Aug. 9
Advertised, Eng. News, Aug. 9 to 30.
Sept. 6. Lock houses, Louisville, Ky.....Aug. 9
Sept. 6. Asphalt paving, Cincinnati, O.....Aug. 16
Sept. 7. Bonds ($14,362), Norwood, O.....Aug. 16
Sept. 8. Asphalt paving, Cincinnati, O.....Aug. 16
Sept. 10. City hall and market, Jacksonville, Fla. Aug. 16
Sept. 10. Bridge, Toledo, O.....Aug. 16
Sept. 10. Bridges, Helena, Mont.....Aug. 16
Sept. 11. Light station, New Orleans, La.....Aug. 16
Sept. 11. Metal work, New Orleans, La.....Aug. 16
Advertised, Eng. News, Aug. 16 to Sept. 6.
Sept. 12. Brick paving, Cleveland, O.....Aug. 16
Sept. 14. Electric light plant, Lancaster, Pa.....Aug. 16
Sept. 15. Water bonds ($100,000), Detroit, Mich. Aug. 16
No date. Sewers, Norristown, Pa.....Aug. 16
" " . Water-wks. extensions, Belleville, N. J. Aug. 16
" " . Brick, etc., Annapolis, Md.....Aug. 16
" " . Borings for water tunnel, Chicago, Ill. Aug. 16
" " . Brick paving, Quincy, Ill.....Aug. 16

INDUSTRIAL NOTES.

THE LAIDLAW-DUNN-GORDON CO., of Cincinnati, O., has orders for 30 hydraulic presses for England and Australia.

THE BROOKS LOCOMOTIVE WORKS, of Dunkirk, N. Y., have put in new scales with a weighing capacity of 100 tons. Two locomotives have been recently shipped to the Toledo & Ohio Central Ry.

CARS.—The Lehigh Valley R. R. has placed orders for 2,000 freight cars as follows: Buffalo Car Mfg. Co., Buffalo, N. Y., 1,000 cars; Lebanon Mfg. Co., Lebanon, Pa., 450; Carlisle Mfg. Co., Carlisle, Pa., 300; Middletown Car Works, Middletown, Pa., 250 cars.

THE LAFAYETTE BRIDGE CO., of Lafayette, Ind., has been awarded the contract for building the machine shops at Lafayette for the Louisville, New Albany & Chicago Ry. They must be finished by Jan. 1, 1895. The shops, which will cover a 40-acre tract of land, will cost $140,000 with the machinery.

THE SIEMENS & HALSKE CO., of Chicago, has leased the plant and shops of the Grant Locomotive Works, at Cicero, Ill., to carry on its business, its own works having recently been destroyed by fire. The Wells & French Car Co. will also occupy a part of the works, and will build the bodies of cars for which the Siemens & Halske Co. has the contract for electrical equipment.

THE NATIONAL SWITCH & SIGNAL CO., of Easton, Pa., has recently completed the interlocking plant at Colton, Cal., for the Southern California Ry., and has finished the changes in the 80-lever interlocking plant at 43d St., Chicago, for the Illinois Central Ry. These changes provide for the use of No. 8 track by the fast suburban service, and are part of a series of changes now being made by the Illinois Central Ry. with a view to increasing the efficiency of the suburban traffic.

THE WADDELL-ENTZ CO., of New York, announces that arrangements have been perfected by which the manufacture of the Waddell-Entz dynamos and motors will be carried on with improved manufacturing facilities and on a more extensive scale than formerly. The machines will be built in Bridgeport, Conn., in a new shop fully equipped with the most improved tools and machinery, overhead traveling crane, etc., and the most ample facilities for turning out the highest class of mechanical work with promptness and despatch. Mr. Waddell still retains his connection with the enterprise, and the Sales Department will be in charge of Mr. J. A. Machado, who has been connected with the Waddell-Entz Co. since its organization. Correspondence and inquiries should be addressed to J. A. Machado, Agent, 203 Broadway, Mail & Express Building, New York city.

NEW COMPANIES.—Consolidated Water Power Co., Grand Rapids, Wis.; $300,000; F. E. Nash, C. A. Spencer and F. McKinnon.——Nay-Aug Shale Brick Co., Scranton, Pa.; $65,000, with $6,500 paid in; Treas., S. W. Roberts.——Greenlee & Forst Oil Co., Jersey City, N. J.; $5,000,000, with $700 paid in; Bernard Forst, Allegheny Pa.; C. D. Greenlee, Butler, Pa., and J. S. Kaufman, Pittsburg, Pa.——Monarch Engine Stop Co., New York, N. Y.; $250,000, with $500 paid in; Joshua F. Bailey, J. S. Bache and Joseph Livingston.——Fort Orange Oil Co.; $500,000, with $2,500 paid in; J. W. Tillinghast, S. W. Rosendale and A. B. Banks, all of New York.——Darrach Car Fender Co., Newark, N. J.; $50,000, with $500 paid in; Carrol Ph. Bassett, F. Frelinghuysen and Marcus L. Ward.——Quadruple Steam Pump Co., Jersey City, N. J.; $200,000, with $10,000 paid in; Wm. J. O'Keil, of Jersey City, and W. E. Hollingshead, of Bayonne, N. J.——Western Iron & Steel Co., Tacoma, Wash.; $100,000; Richard Brown, of Youngstown, O.——Panama Construction Co., Chicago, Ill.; $100,000; F. F. Vellette, Geo. H. Hall and Levi P. Wilcox.——Stanberry Pressed Brick Co., Stanberry, Mo.; $20,000; D. F. Hall, Frank Jones and J. D. Halstead.

NOTICE TO CONTRACTORS.

PAVEMENTS.—CITY OF DUNKIRK, N. Y

Notice is hereby given that the Common Council of the City of Dunkirk will receive bids for the work and materials for improving by grading and paving or macadamizing the Fourth Section of Central Avenue in said city, from the end of the now macadam pavement on said Central Avenue to the city line, upon specifications to be delivered to any person desiring to make such bid on the job of doing the work and furnishing the materials therefor, which said bids will be opened and examined by the Common Council of the City of Dunkirk at the Council Chambers in said city on the 30th day of August, 1894, at 8 p. m. All bids must be made upon the bidding sheets furnished by the city, and must be accompanied with a certified check payable to the order of the City Treasurer of the City of Dunkirk, for five per centum of the costs of such improvement at the price fixed by such bidder. The said Common Council hereby reserves the right to reject any or all bids that may be made.

The approximate amount of work to be done is as follows:

3,706 cu. yds. excavation.
8,800 sq. yds. paving.
3,960 lin. ft. curbing, furnished and set.
3,960 lin. ft. 4-in. drain tile.

All communications respecting the foregoing resolution and notices should be addressed to

J. M. HACKETT,
City Engineer, Dunkirk, N. Y.

Dated Dunkirk, N. Y., Aug. 10, 1894.

JNO. E. MALONEY,
33-2t City Clerk of the City of Dunkirk.

WATER-WORKS.

Sealed bids will be received at the office of the City Clerk of De Kalb, Ill., until 8 o'clock P. M., Sept. 4th, 1894, for the improvement of the water-works system of said city. The following items will be required:

Two high grade boilers;

Pumping plant for domestic service, including engine, deep well power pump and power service pump;

One duplex pump for fire service of one million gallons daily capacity;

One half-million-gallon reservoir;

99 tons of 10 and 12 inch cast iron pipe with special castings;

Pipelaying, including removal of old pipe.

A certified check must accompany each bid for at least five per cent. of the amount of bid; said check to be not less than $100 in any event.

Bids on boilers and machinery will be accepted from manufacturers only.

Plans and specifications ban be seen and specifications for boilers, machinery and cast iron pipe, and also general form of contract and proposal, can be obtained at the office of the undersigned. The city reserves the right to reject any or all bids.

DANIEL W. MEAD, Consulting Engineer, Rockford, Ill.
E. A. PORTER, City Clerk, De Kalb, Ill.
33-2t

PROPOSALS FOR BUILDING MAIN TRUNK SEWER.

Sealed proposals for furnishing and laying Section No. 2 of a brick trunk sewer will be received by the Board of Public Works of the city of Niagara Falls, N. Y., up to 8 o'clock P. M., Aug. 24, 1894.

Plans and specifications may be seen at the office of the City Engineer, No. 55 Gluck Building.

The quantities will consist approximately of
2,450 ft. of brick sewer, 5 ft. diameter.
11,157 yds. of earth excavation.
3,304 yds. of rock excavation.

Bids will not be received unless made on printed blanks inclosed in printed envelopes furnished by the City Engineer, or if at all informal.

A certified check for the sum of one thousand two hundred dollars ($1,200), payable to the city of Niagara Falls, must accompany each proposal, which sum will be forfeited in case of failure to enter into contract if same is awarded.

The Board of Public Works reserves the right to reject any or all bids.

D. PHILLIPS,
A. SCHOELLKOPF,
GEO. W. WRIGHT,
JOHN BROWN,
M. B. BUTLER,
Board of Public Works.
L. P. DAYTON, City Clerk.
33-1t ALBERT H. PORTER, City Engineer.

PROPOSALS FOR BUILDING MAIN TRUNK SEWER.

Sealed proposals for furnishing and laying Section No. 1 of a brick trunk sewer will be received by the Board of Public Works of the City of Niagara Falls, N. Y., up to 8 o'clock P. M., August 24th, 1894.

Plans and specifications may be seen at the office of the City Engineer, No. 55 Gluck Building.

The quantities will consist approximately of:
2,470 feet of sewer, 5 feet diameter.
11,814 yards of earth excavation.
3,277 yards of rock excavation.

Bids will not be received unless made on printed blanks inclosed in printed envelopes furnished by the City Engineer, or if at all informal.

A certified check for the sum of One Thousand Two Hundred dollars ($1,200), payable to the city of Niagara Falls, must accompany each proposal, which same will be forfeited in case of failure to enter into contract if same is awarded.

The Board of Public Works reserves the right to reject any or all bids.

D. PHILLIPS,
A. SCHOELLKOPF,
GEO. W. WRIGHT,
JOHN BROWN,
M. B. BUTLER,
Board of Public Works.
L. P. DAYTON, City Clerk.
33-1t ALBERT H. PORTER, City Engineer.

PROPOSALS FOR SEWERS.

Sealed proposals for building sewers in the city of Plainfield, N. J., will be received by the Common Council of said city until 8 o'clock p. m. on the 21st day of August, 1894, at which time they will be opened. Each proposal must be accompanied by a certified check for $1,000, payable to the Treasurer of the city of Plainfield, and no proposal will be considered unless so accompanied.

The Engineer's estimate of the quantities of material required and the work to be done is approximately as follows:

3,780 feet 18-inch pipe sewer.
6,130 feet 15-inch pipe sewer.
6,570 feet 12-inch pipe sewer.
1,095 feet 10 inch pipe sewer.
2,910 feet 8-inch pipe sewer.
960 Y-branches.
67 manholes.
25 lampholes.
2 150-gallon flush tanks.
1 1,000-gallon flush tank.
5,000 feet tile underdrains.

Plans may be examined and forms of proposal, specifications, etc., may be obtained at the office of the Engineer, 109 Park avenue, Plainfield, N. J.

The right to reject any or all bids is expressly reserved by the Common Council.

All proposals must be indorsed "Proposals for Sewers," and addressed to James T. MacMURRAY, City Clerk, 109 Park avenue, Plainfield, N. J. 32-1t

NOTICE TO CONTRACTORS.

Sealed proposals will be received by the Board of Water Commissioners of the Village of Richmondville, N. Y., at their office in said village, until 2 o'clock P. M. on the 29th day of August, 1894 (at which time and place the bids will be publicly opened), for the material and labor required to construct water-works in the said village of Richmondville, N. Y. Proposals must be made on blanks furnished by the Commissioners, and must be accompanied with cash, certified check or draft for $500, payable to the Treasurer of the Board of Water Commissioners, as a guaranty for the execution of a contract if the proposal shall be accepted. The check will be returned upon the execution of said contract and bonds. The checks of unsuccessful bidders will be returned immediately after the awarding of the contract. The right is reserved to reject any and all proposals. Blank bids and specifications can be obtained of the Water Commissioners, and maps and plans will be exhibited by them ten days prior to the day of letting.

J. C. SMITH,
A. J. WHARTON,
A. H. BURNESON,
E. L. SNYDER,
Board of Water Commissioners of the Village of Richmondville, N. Y. 33-2t

U. S. ENGINEER OFFICE, Wilmington, N. C., July 25, 1894.—Sealed proposals for dredging at Ocracoke Inlet, N. C., will be received here until 11 A. M., Aug. 25, 1894, and then publicly opened. All information furnished on application. W. S. STANTON, Major Corps of Engineers, U. S. A. 31-4t

NOTICE TO WATER-WORKS CONTRACTORS.

Fort Dodge, Iowa, Aug. 7, 1894.

Sealed proposals for the construction of a system of water-works will be received by the City Council at its rooms until 2 o'clock p. m. of the 22d day of Aug., 1894, at which time they will be publicly opened and read.

The work will comprise the following:

1st. The furnishing and laying of 3,744 ft. of 10-in. pipe, together with necessary special castings, valves and hydrants for same, and connection of same to present pipe system.

2d. The construction of a water tank with steel tower.

3d. A steam plant of two 100-HP. boilers.

4th. A steam pump with appurtenances, fittings, etc.

5th. A filter gallery.

Bids will be received for the entire work complete, or separate bids for any one or more of the five portions as above divided. The right is reserved to accept such single bid or combination of bids as may be deemed for the best interests of the city. Also to reject any or all bids.

A certified check, made payable unconditionally to the City Treasurer of Fort Dodge, Iowa, must accompany each bid—a check in an amount equal to $75 for each portion bid upon.

Plans and specifications will be on file and can be seen after Aug. 7 at the office of the City Clerk, in Fort Dodge, and Chas. F. Loweth, Consulting Engineer, 94 East 4th street, St. Paul.

By order of Council.

C. L. GRANGER,
Chairman Water Committee.
CHAS. F. LOWETH,
33-2t Consulting Engineer, St. Paul, Minn.

PROPOSALS.

Sealed proposals will be received at the office of the Armstrong Water Company, Kittanning, Pa., until Saturday, Aug. 25, for building a reservoir for said water company. Plans and specifications can be seen at the office of the company. W. B. MEREDITH,
32-2t Treasurer.

OFFICE OF THE LIGHTHOUSE ENGINEER, Seventh District, New Orleans, La., August 4, 1894.—Sealed proposals will be received at this office until 2 o'clock p. m. of Tuesday, the 11th day of September, 1894, for furnishing materials and labor of all kinds necessary for the completion and delivery of the metal-work for the Crooked River Light-Station, Florida. Plans, specifications, forms of proposal and other information may be obtained on application to this office. The right is reserved to reject any or all bids and to waive any defects. JAMES B. QUINN, Major of Engineers, U. S. Army, Lighthouse Engineer, Seventh District. 33-4t

OFFICE OF THE COMMISSIONERS D. C., Washington, D. C., August 3, 1894.—Sealed proposals will be received at this office until 2 o'clock p. m., Thursday, August 30, 1894, for grading and graveling 12th street N. E., extended, and Pennsylvania avenue extended. Blank forms of proposals, specifications and all necessary information may be obtained at this office. J. W. ROSS, GEORGE TRUESDELL, CHAS. F. POWELL, Commissioners D. C. 33-2t